Learning in the Prairie

Beilfuss

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Meredith L. Beilfuss
LEARNING IN THE PRAIRIE

Meredith L. Beilfuss, M.A.
Western Michigan University, 2002

This research focused on fieldwork in geography and science education relative to the high school curriculum. First, the literature was reviewed to analyze the pedagogical and cognitive benefits of using fieldwork and how fieldwork might enrich the high school social studies and science curriculum in Michigan. Second, prairie curriculum resources were evaluated for suitability using the Michigan Education Standards and the National Standards for Geography. Finally, two groups of high school students engaged in fieldwork, using two different methods, photography and sketching, and were compared for their pre and post fieldwork knowledge of prairie ecological concepts. The pre and post tests revealed that of the two fieldwork methods, the photography group showed the largest increases in understanding, however no statistically significant difference was observed.
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CHAPTER I
INTRODUCTION

Background

Over the past 300 years the Earth’s biota has undergone massive changes: world vegetation cover has been profoundly altered, the world’s wild land and sea animal populations have been sharply reduced in number and range, and even the physical composition of the oceans and the atmosphere may have experienced subtle changes. At the same time (human) control over the natural environment has risen to the point that the natural order is virtually an anthropogenic or (human) determined system (Richards, 1986).

As the planet Earth becomes ever more exploited for the purposes of settlement, industry, agriculture, and resource acquisition, the importance of natural areas continues to increase. The environmental exploitation is expected to continue as the population continues to increase. It is estimated that less than 10% of the land in the world has been unaltered by human impact (Wilson, 1995). The spread of human rural settlement and the expansion of arable land since 1700 have played a significant role in changing the environment. The most significant changes have occurred since 1860, with the rapidly increasing conversion of land for agricultural purposes (Richards, 1988).

Tallgrass prairies are one of many ecosystems that have been altered by human settlement and agricultural practices. Although humans had modified the prairie vegetation for thousands of years, and in fact may have
caused significant extinctions of large mammals, a healthy and well-functioning prairie ecological system was maintained (Rowe and Coupland, 1984). The changes brought about by Europeans who settled the world's prairies have been substantial. The alterations include the transformation of the societies and economies of the indigenous peoples, the extirpation of the bison, and the conversion of prairie to European style agriculture (Finnamore, 1992). The major agents, fire and buffalo grazing, that acted to maintain the prairie were removed while major tracts of grasslands were destroyed. Natural cycles and processes that functioned for millennia were significantly impacted. Land use changes have put pressure on the biotic communities and have destroyed many species of plants and animals, while placing many more in peril (Hall, 1998). Current estimates place the amount of prairie remaining in the United States at as little as 0.1% of its original extent (Samson and Knopf, 1994). Specifically, the tallgrass prairie was plowed for agriculture or lost to the invasion of trees and shrubs as a result of fire suppression (Thornton and Millenbah, 2000). Throughout the former range of the tallgrass prairie, only small and scattered remnants remain (Steinauer and Collins, 1996). The populations of many species of animals and plants associated with these areas have declined dramatically (Knopf, 1996).

Michigan is located in the range of the grassland biome of the Midwest (Cochrane and Iltis, 2000) and is at the eastern boundary of the
tallgrass prairie (Transeau, 1935) and prairie/forest ecotone (Cochrane and Iltis, 2000). Michigan’s original prairies were pockets of approximately 50-100 acres distributed across the southern portion of the Lower Peninsula (Brewer et al. 1984). Historically, this area was characterized by remnant patches of prairie coexisting with patches of savanna and oak, or oak-hickory forests (Transeau, 1935). Generally, this area was regarded as being a part of the tallgrass prairie due to the predominance of tallgrass prairie grasses and forbs (Transeau, 1935; Thompson, 1975; Risser et al., 1981; Brown, 1985). Few areas were saved from the plow. Before their intrinsic value was realized, these rich ecosystems were all but erased from Michigan’s landscape.

As the human population increased, development of the landscape caused a decrease in the size and number of greenspaces available for preservation. Scientific knowledge and skills enable people to make informed decisions by considering the consequences of our actions. The scientific principles surrounding environmental issues, such as prairies represent, illustrate why scientific literacy is so important to society (Gill, 1999). Current educational reform efforts are focused on developing scientific literacy and on designing curricula that will enable students (in K-12 science education programs) to become scientifically literate.

The American Association for the Advancement of Science (AAAS) created Project 2061 which, in three phases, contributes to the reform of
education in science, math, and technology. The first phase resulted in a report entitled, "Science for All Americans". The report described the scientifically informed person in terms of literacy in science (Rutherford, 1990). According to Project 2061, the scientifically literate person has the following traits:

1. Being familiar with the natural world and recognizing both its diversity and its unity.

2. Understanding key concepts and principles of science.

3. Being aware of some of the important ways in which science, math, and technology depend upon one another.

4. Knowing that science, math, and technology are human enterprises and knowing what that implies about their strengths and limitations.

5. Having a capacity for scientific ways of thinking.

6. Using scientific knowledge and ways of thinking for individual and social purposes (AAAS, 1993).

Scientific literacy, as defined above, continuously develops as the science curriculum incorporates a wide variety of learning experiences that clearly emphasize real-world doing (hands-on), cooperative and individual performance, interdisciplinary connections, assessment of risks and benefits while making choices, and responsible thinking and decision making in real-world situations. If students are only exposed to a collection of facts, isolated in a classroom, instead of being given the opportunity to understand the key concepts by exploring and investigating, their studies will not adequately
prepare them to evaluate environmental issues. Students should be able to fashion judgments based on hypotheses and evidence, and not upon unfounded beliefs. As a result of achieving scientific literacy, students will begin to see connections between basic science and real world situations, and acquire the skills necessary to propel them into life long learning (Gill, 1999). “For science curriculum developers, this means that a science education program enriching enough to facilitate the continuous development of scientific literacy requires powerful learning episodes that are relevant and engaging to all learners” (Horton, 1998).

The prairie restoration process is a powerful resource for learning about native plant communities, and more importantly, the natural processes that rule them. The practical significance for involving students in this process is that they explore the scientific process as part of a real world investigation (Murray, 1996). The ultimate goal of the environmental and ecological education that takes place during the prairie restoration process, other than to generate knowledge, is to develop students’ awareness and concern about the total ecosystem, its associated problems, and to shape students behavior concerning the environment and conservation (Bogner, 1998). Restored prairie areas allow the observation of how prairie ecosystems function, and can provide students with the opportunity to learn about the prairie. This information and related concepts are unknown to
many people. The restored prairie can be used as a living laboratory to further knowledge of these systems and how to restore them.

A restored landscape provides the opportunity to engage students in: scientific inquiry in a meaningful context; hands-on learning; real-life decisions that build confidence and resiliency; interdisciplinary learning in a broad context; work among peers, classes, grades, and schools; and community involvement through cooperative projects (Murray, 1996). Taking part in the study of a restored prairie can promote geographic and scientific literacy for our students.

The Research Problem

How can we best prepare students to think critically about environmental issues like the need to conserve or restore prairies in Michigan? The research question encompasses numerous cognitive, pedagogical, and curriculum considerations, which suggest a number of subsidiary questions, such as: Where in the high school curriculum could the environmental issue of prairie loss and restoration be effectively taught? What instructional design theory would best serve this subject and how should it be taught? How does learning occur and how do different fieldwork methods facilitate learning? Not all of these questions could be addressed in this research. However, the consideration of each question is
important in order to present a logical and reasonable rationale for selecting fieldwork as the focus of the present research.

In this research I am going to compare two methodologies that may be used within fieldwork as it is carried out in geography and science education. The first methodology is field sketching as a means to record field observations for later analysis in the classroom. The second is the use of photography to record field observations for later analysis. In this research, I will examine specifically the attentiveness to the fieldwork task and its effects on student learning that are a result of students using either field sketching or photography in their fieldwork.

1. How could the environmental issue of prairie loss and restoration be incorporated into the curriculum? In order to achieve applicability to a high school classroom at the local and national level, this researcher studied the content standards and benchmarks upon which curricula are developed. This study reviews the scope of existing prairie education curricula, and selects, or develops, activities that will meet specific Michigan content standards and benchmarks (Michigan Department of Education, 1995), the AAAS Benchmarks for scientific literacy (AAAS, 1993), and the National Geography Standards for geographic literacy (Geography Education Standards Project, 1994).
Two prominent prairie curriculum guides were reviewed. Molly Murray (Murray, 1993), a prairie educator who wrote the guide “Prairie Restoration for Wisconsin Schools”, believes that the restoration process is a powerful tool for learning about this native habitat. The guide gives instructions on how to restore prairie habitat on school grounds and details activities for educators to use with students in the prairie habitat. In Iowa, a similar publication titled “Project Bluestem” (Walnut Creek National Wildlife Refuge, 1995), guides Iowa educators on the best activities to use when visiting or studying prairie ecosystems with students. Both of the aforementioned publications are excellent resources, however, there are no activities that relate specifically to Michigan state goals and objectives.

2. What instructional design theory would best serve this subject and how should it be taught? Learning theories provide structure for the instructional aspects of teaching by suggesting methods that complement perspectives on learning. This researcher selected field instruction as the focal instructional activity for this study because it emphasizes experiential learning and because it can serve as a model for a constructivist approach. However, little educational research exists in the area of comparative effectiveness of various instructional strategies, though Wise and Oakey’s (1983) meta-analysis suggested that nontraditional learning environments for teaching and learning were more effective than traditional ones (Lisowski
and Disinger, 1991). Field study and civic participation in such activities as prairie restoration are considered non-traditional methodologies mainly because they are seldom used.

Research studies have examined the influence of field strategies on furthering student understanding and retention of targeted concepts. For example, a study by Lisowski and Disinger provided support for the premises that (1) gains in conceptual understanding are positively related to instructional emphasis; and (2) fieldwork based programs in the sciences are effective in assisting students' understanding and retention of selected ecological concepts (Lisowski and Disinger, 1991).

3. How does learning occur and how does the fieldwork method facilitate learning? A particular feature of environmental learning is the close identification with outside-the-classroom experiences. However, "in-the-environment" learning usually concentrates on affective, rather than cognitive, objectives and methods. Likewise, most of the research literature dealing with learning in the environment centers on noncognitive areas (Disinger, 1984). A review of studies dealing with cognitive learning in the environment indicates the existence of some, but infrequent, cognitive-focused "in-the-environment" education and a meager research base in this area (Lisowski and Disinger, 1991). Thus, a good deal remains to be researched about cognitive learning "in-the-environment" particularly about
how effective it may or can be (Lisowski and Disnger, 1991). As part of this research it is important to investigate student’s understandings of prairie ecological concepts and whether fieldwork activities assist in the clarification of cognitive conceptual knowledge. This study investigates the theory that students retain concepts learned before, during, and after direct involvement in a prairie outdoor fieldwork experience.

As part of this research of “in-the-environment” learning, high school students will use sketching and photography as fieldwork methods. Sketching is a technique that is used widely in geography and science classrooms. Science and geography educators recognize the usefulness of sketching and a good deal of time is used on it in the classroom, lab, and in the field (BSCS 1992). However, very little research exists as to its effectiveness as compared to similar methods. “Oddly, teachers spend little or no time on students’ drawing skills or on how their work will be assessed and graded” (Dempsey, 2001). “As a result, many students are intimidated by drawing exercises and resort to copying drawings from lab manuals and textbooks” (Dempsey, 2001). Careful observation and interpretation of nature, both key components of the scientific process (National Science Education Standards 1996), are lost unless time is devoted to drawing skills.

Prairie plants, or any plant for that matter, are a wonderful way of introducing students to scientific sketching because they are non-mobile, and
show a great deal of variation. The sketching techniques are tools that help students capture such details in the form of a drawing. Sketching requires attention to the smallest details and as students sketch, they need to closely observe how the specimen is formed. A photograph shows form but not all the minutiae an observer may record in a sketching. Qualitative information in nature can, therefore, be collected in the form of a drawing, which acts as a vehicle for future observation, interpretation and discussion (Dempsey, 2001).

Photography is a technique that is widely popular among the general public for capturing observations of the people and environment. Photography is also used for scientific research, ranging from aerial photography to laboratory time-lapse photographs. However, that popularity to the public and the use in science has not permeated high school geography or science education. Fieldwork that is practiced less frequently than other types of geography and science education investigations, such as videotape and computer terminal viewing, has little evidence in the literature of the use of photography. One exception is the ARGUS Project of the Association of American Geographers (AAG, 1995), in which photo journals, photographic field trips, and time-sequence photographs from the same location, or aspect, are introduced as a means to effectively teach geography. However, there is no prior research in geography or science education that
investigates the benefits of photography as a method of data collection in fieldwork by high school students.

The research design and methodologies for this investigation are discussed in subsequent chapters. The proposed outcomes of this research will include a rationale for fieldwork and prairie activities in high school science and geography education in a selected region of southwest Michigan, and research data comparing the use of field sketching and photography as field data collection methods. The principle objective of this research is to compare the effects of two methods for observation that students may use in fieldwork: field sketching and photography. The research does not examine larger issues regarding the benefits of fieldwork compared to other instructional methods.
CHAPTER II

REVIEW OF RELATED LITERATURE

To establish a cognitive and pedagogical rationale for employing fieldwork in high schools, a review of current research literature was conducted. The survey was divided into six sections: scientific literacy, geographic literacy, education for citizenship, the role of fieldwork in education, the conceptual and instructional theories of learning, and fieldwork as an instructional tool.

The discipline of geography has been undergoing a reform in the United States during the past decade. Geography's research focus on the study of human society and the environment through the perspectives of place, space, and scale is finding increased relevance in fields ranging from ecology to economics. At the same time, many of its research tools and analytical methods have moved from the research laboratory into the mainstream of science and business. Geography is undergoing a rebirth in education as well—it has become an organizing framework for presenting a wide variety of classroom subjects. It is recognized as an important subject in American schools, and enrollments in geography programs in American colleges and universities are increasing sharply to meet demands from employers for geographically literate students (Rediscovering Geography Committee, 1997).
The Goals 2000: American Education Act declared that "by the year 2000, all students will leave grades 4, 8, and 12 having demonstrated competency over challenging subject matter including English, mathematics, science, foreign languages, civics and government, economics, arts, history, and geography, and every school in America will ensure that all students learn to use their minds well, so they may be prepared for responsible citizenship, further learning, and productive employment in our Nation's modern economy" (Goals 2000: Educate America Act, 1994) (Figure 1). The integration of science with other subject areas, such as geography or history, provides students with opportunities to encounter science in non-science classrooms and in contexts where the agenda is not focused solely on learning science content. Among the social science disciplines, only geography has a scientific structure as the discipline providing connections to the natural and physical sciences (National Commission on Social Studies, 1989).

The Goals 2000 of the 1990's sent a strong message to our schools that scientific literacy, geographic literacy, and citizenship were all important goals for pre-collegiate education.
The National Education Goals

Goal 1: By the year 2000, all children in America will start school ready to learn.

Goal 2: By the year 2000, the high school graduation rate will increase to at least 90 percent.

Goal 3: By the year 2000, American students will leave grades four, eight, and twelve having demonstrated competency in challenging subject matter, including English, mathematics, science, history, and geography; and every school in America will ensure that all students learn to use their minds well, so that they may be prepared for responsible citizenship, further learning, and productive employment in our modern economy.

Goal 4: By the year 2000, U.S. students will be first in the world in science and mathematics achievement.

Goal 5: By the year 2000, every adult American will be literate and will possess the knowledge and skills necessary to compete in a global economy and exercise the rights and responsibilities of citizenship.

Goal 6: By the year 2000, every school in America will be free of drugs and violence and will offer a disciplined environment conducive to learning.

Figure 1. The National Education Goals.

Scientific Literacy

The term 'scientific literacy' was first used in the 1950s to describe what was necessary for a person to be a productive, happy, and model citizen (Laugksch, 1998). Over time, the term scientific literacy has been defined in other ways, from simple explanations to the more complex, modern definitions we see today. The definition of scientific literacy is important, because it provides the basis on which educators answer questions such as: what science content is important to teach in schools; what parameters are important within the content; and, how should science be taught. A review of the published literature next provides an overview of the definition of scientific literacy. It is placed in a historical context and followed by a discussion of the various current definitions, including the researcher's definition for scientific literacy.

Historical Context

Where we are now is influenced by our past. In December 1892, eighteen people met at the University of Chicago to advise the "Committee of Ten" on science preparation needed for college admission. These teachers and faculty members from private and public colleges and universities decided that at least one year of biology, followed by one year of chemistry, and one year of quantitative physics, would best prepare young people to grow up to be "just like them" (Hoffman, 1993). This committee made
recommendations that were based on the idea that students in high school would best be served by a curriculum that would prepare them for college science, even though only a small percentage of high school students actually attended college. This idea of selecting the science content based on preparing students for the college curriculum gradually began to change as more and more students entered high school without the intention of going to college. “In the relatively short time between 1893 and 1920, the justification for science in the curriculum had shifted from an argument based almost exclusively on science’s ability to develop one’s intellectual skills, to one based on science’s ability to develop an individual who would be a happy and contributing member of society” (DeBoer, 1991). In 1918, the Commission on Reorganization of Secondary Education published a report, ‘Cardinal Principles of Secondary Education’. The list of principles published in this report became known as the ‘Seven Cardinal Principles” (DeBoer, 1991). These principles stated that a student should receive an education in the following areas: health; command of fundamental processes; worthy of home ownership; vocation; civic education; leisure; and ethical character. The Committee on Science was established by the commission to justify the presence of science courses in the high school curriculum. As a result, it was recommended that it was more important for students to take science courses in order to develop general thinking skills. Four subcommittees, of the
Committee on Science, made more specific recommendations on the goals for science education. These goals included: improve the general welfare of society; develop science related vocational interests; develop an enjoyment of nature; develop the student's ability to observe, make careful measurements of phenomena, to classify those observations, and to reason clearly from what they observed. The science educators on these committees were helping to formulate a definition of scientific literacy. The focus of science education shifted from college preparation to teaching science for all students.

The National Education Association (NEA) published educational objectives in 1944, entitled “Education for all American Youth” (Wood, 1997). It stated that, “schools should be dedicated to the proposition that every youth, regardless of sex, economic status, geographic location, or race, should experience a broad and balanced education” (Wood, 1997). In 1952, the NEA revised their objectives to specifically include the sciences. “All youth need to know how to understand the methods of science, the influence of science on human life, and the main scientific facts concerning the nature of the world and man” (Wood, 1997).

Members of the NEA were not the only people concerned about science education in the 1950s. After the launch of ‘Sputnik’, the Soviet satellite, parents became increasingly aware that their children should be receiving the kind of science education that would allow them to compete,
both scientifically and technologically, in a global society (Laugksch, 1998). The Soviet advance in space was the impetus that led the United States to invest large amounts of money in science curricula that would enable the United States to compete.

The period of the late 1970s and early 1980s was a time when Americans were facing two important challenges. The first was the emergence of Japan as an economic power, and the belief that America's international economic competitiveness and industrial leadership was on the decline. The second was America's poor standing in science achievement when compared to the rest of the world. These challenges led to a perceived crisis in science education by governmental policy makers because American science and technology were seen as the fundamental basis for economic progress (Laugksch, 1998). The National Commission on Excellence in Education published, 'A Nation at Risk' (The National Commission on Excellence, 1983), which raised concerns about the adequacy of science education. A Nation at Risk, and the subsequent documents regarding its support, revived an interest in scientific literacy as necessary for all students. The report emphasized the idea that all students should be scientifically literate, and not just those that would receive higher education.

The idea of science literacy for all students became the primary goal of Project 2061, which was initiated by the American Association for the
Advancement of Science in 1986 (AAAS, 1993). The project has a three-phase action plan that will contribute to the reform of education in science, math, and technology. The first phase of Project 2061 led to a report entitled ‘Science for All Americans’. The report gave a basic description of scientific literacy, and recommended basic learning goals for all American children to meet in order to achieve scientific literacy (AAAS, 1993). The recommendations were for students to:

1. Be familiar with the natural world and recognizing both its diversity and its unity.
2. Understand key concepts and principles of science.
3. Be aware of some of the important ways in which science, mathematics, and technology depend upon one another.
4. Know that science, mathematics, and technology are human enterprises and know what that implies about their strengths and limitations.
5. Have a capacity for scientific ways of thinking.
6. Use scientific knowledge and ways of thinking for individual and social purposes (AAAS, 1993).
Recent Definitions

The term, scientific literacy, has different meanings and interpretations. Some are based on research and others are based on personal perceptions. The second phase of Project 2061 led to the creation of ‘benchmarks’, or statements of what all students should know or be able to do in science (AAAS, 1993). The project defines scientific literacy as, “requiring understandings and habits of the mind that enable citizens to grasp what those enterprises are up to, to make some sense of how the natural and designed world work, to think critically and independently, to recognize and weigh alternative explanations of events and design trade-offs, and to deal sensibly with problems that involve evidence, numbers, patterns, logical arguments, and uncertainties” (AAAS, 1993). The National Science Education Standards use a similar definition: “having the knowledge and understanding of scientific concepts and processes required for personal decision making, participation in civic and cultural affairs, and economic productivity” (National Research Council, 1996).

The Researcher’s Definition

This researcher believes that in order for students to be scientifically literate they must be: familiar with the natural world; understand the laws that govern nature; understand the principles of science; and, understand how to think or reason scientifically. Knowing and understanding science
will enable students to make better decisions about themselves and their interactions with the natural world. For example, the scientific issues surrounding environmental problems illustrate why teaching scientific literacy is important. Understanding the issues such as habitat loss, or biodiversity, is expected of the citizens in our society. Using scientific knowledge and ways of thinking for individual and social purposes is important to understanding current and future environmental issues. Students need the ability to evaluate the credibility of differing arguments making scientific or political claims concerning environmental or ethical issues. If students are only exposed to a collection of facts, instead of understanding key concepts and principles, it will not prepare them to evaluate issues. Students should be able to fashion judgments based on hypothesis and evidence, and not on unfounded beliefs. As part of scientific literacy, students should begin to see connections between basic science and real-world situations and acquire the skills necessary to propel them into lifelong learning (Gill, 1999).

Geographic Literacy

Geography is included as a core subject in Goals 2000: Educate America Act and is recognized as the culmination of a decade of reform in geography education. There is now a widespread acceptance among the people of the United States that being literate in geography is essential if
students are to earn a decent living, enjoy the richness of life, and participate responsibly in local, national, and international affairs (Geography Education Standards Project, 1994). Out of this recognition that a geographically literate society is important, the Geography For Life: National Geography Standards were developed in 1994.

Geography is an integrative discipline that studies the interactions between people and their environments on or near the earth's surface. All people depend upon and share common environmental elements of land, water, and air. People move about in the environment, alter the landscape, use natural resources, and pollute the air and water, to name only a few interactions. In doing so, they are acting as citizens of a community, sharing and using the environment (Stoltman, 1990).

The four dominant traditions in the discipline of geography are as: a physical science, human-environment relationships, a spatial science, and a regional science. Human-environment relationships is the tradition that includes the activities people undertake to change, control, harness, and use the earth and its resources. People in rural and urban environments, in mountainous terrain, on river flood plains, in tropical forests, and in deserts all established relationships with the natural environment. Increasingly, technology allows people to take control of many elements of their
environment and convert large areas from natural to human landscapes (Stoltman, 1990).

"Geographical literacy demands that all students gain a common knowledge of their immediate and world environments" (Natoli and Gritzner, 1988). Among the important characteristics of geography is its concern for the earth as an ecological system. Literacy and competency in geography, therefore, are essential if citizens are to exercise rights, accept responsibilities, and preserve the natural environment (Stoltman, 1990), such as the tallgrass prairies that are the focus of this research.

Education for Citizenship

Science and geography education have both made cases for the important role they play in the outcomes of responsible citizens. What are those linkages between geography education and citizenship? Historically, the relationship between geography education and citizenship has been cited by various authors and commissions studying curriculum (Butts 1980). "One early and direct reference was in the Cardinal Principles of Secondary Education, developed by the Commission on the Reorganization of Secondary Education in 1918, which stated that while all subjects should contribute to good citizenship, the social studies- geography, history, civics, and economics- should have this as their dominant aim. Geography should show the
interdependence of men while it shows their common dependence on nature” (as cited by Stoltman, 1990).

More recent reforms in geography education came about through legislation of the Goals 2000: Educate America Act. “By the year 2000, all students will leave grades 4, 8, 12 having demonstrated competency over challenging subject matter including...geography, and every school in America will ensure that all students learn to use their minds well, so they may be prepared for responsible citizenship, further learning, and productive employment in our Nation’s modern economy” (Goals 2000: Educate America Act, Section 102, 1994).

Paul Woodring (1983), in his review of the debates over education, argued for the importance of geography education for citizenship. He states: “A knowledge of landscapes, climates, boundaries, peoples, animals, plants, and other resources of the various continents, islands, and states, is basic to the study of history, political science, economics, geology, biology, and many other disciplines. It is also basic preparation for living in, understanding, and moving about in today’s world” (as cited by Stoltman, 1990).

Land as a resource and the different uses for land are important geographic and value-laden issues (Stoltman, 1990). The human-environment tradition of geography continues to provide citizens with knowledge about how humans affect and are affected by the environment.
This tradition provides citizens with an understanding of the range of choices a particular environment offers as well as the limitation a particular environment presents (Stoltman, 1990).

Contact with actual issues at the local, national, and global levels allows students to discover problems, to deepen their critical thinking and judgement, to develop their respect for the environment and for the management of resources. It also allows students to develop their sense of responsibility when facing the problems derived from the observation of an ecosystem, like a prairie. This observation leads to the achievement of one of the social goals of education: civic formation (Ostuni, 2000).

Learning Theory and Instructional Models

Many curriculum theories (what to teach) are based on a philosophy or a set of values (why to teach). Teaching about environmental issues, such as prairie ecosystem destruction or prairie reconstruction, using fieldwork methods, would best fall under the philosophical views of the Progressivists. The Progressivists believe that education should focus on the whole child, rather than on the content or the teacher (Cohen, 1999). This educational philosophy stresses that students should test their ideas by active experimentation. As the students experience their world, questions arise that can be used to focus their learning. The curriculum content is a derivative of the students' interests and questions. Learning is viewed as active, not
passive. "The learner is a problem solver and thinker who makes meaning through his or her individual experience in the physical and cultural context. Effective teachers provide experiences so that students can learn by doing" (Cohen, 1999).

Related to the educational philosophies are theories of learning that focus on how learning occurs and their psychological orientations. Learning theories provide structure for the instructional aspects of teaching by suggesting methods that complement perspectives on learning (Reigeluth, 1999). Each theory of learning is related to a particular educational philosophy, but may have other influences as well. There are four main theories of learning. They are Information Processing, Behaviorism, Constructivism, and Humanism. The theories of learning focus on descriptions of how learning occurs. The first two theories, Information Processing and Behaviorism, can be thought of as transmissive in that information is given to learners. The second two, Constructivism and Humanism, are constructivist in that the learner has to make meaning from experiences in the world (Cohen, 1999). This research will focus on the Constructivist theory of learning as the basis for the use of fieldwork as an instructional method.

Constructivists believe that the learner actively constructs his or her own understandings of the world through interaction with objects, events,
and people in the environment, and reflects on these interactions (Cohen, 1999). Early perceptual psychologists believed that sense making was to have come from the making of wholes from bits and pieces of objects and events in the world and that meaning was the construction in the brain of patterns from these pieces. “For learning to occur, an event, object, or experience must conflict with what the learner already knows. Therefore, the learner’s previous experiences determine what can be learned. Motivation to learn is experiencing conflict with what one knows, which causes an imbalance, which triggers a quest to restore the equilibrium” (Cohen, 1999). The psychologist Piaget described intelligent behavior as adaptation. The learner organizes his or her understanding in organized structures. At the simplest level, these are called schemata’s. When something new is presented, the learner must modify these schemata’s in order to deal with the new information. This process, called equilibration, is the balancing between what is assimilated (the new) and accommodating the change in the schemata (Cohen, 1999).

**Conceptual Development and Learning**

What are some of the characteristics of understanding? Reigeluth and Moore state that understanding is “primarily a matter of learning the relationships among elements of knowledge” (Reigeluth, 1999). The learner organizes these elements of knowledge into knowledge structures or
‘schemata’ (Reigeluth, 1999). Perkins and Unger (Reigeluth, 1999), as well as other cognitive scientists, suggest that to have an understanding of a subject requires a good mental model or set of schemata. However, this statement is amended to include the use of the model to plan and predict as a criteria for understanding. P.N. Johnson-Laird also believes that the development of a mental model is a prerequisite to deep understanding. “Similarly as adults become more competent in a particular domain, they develop a richer model of that domain” (Johnson-Laird, 1983). Schemata are comprised of various elements of knowledge. In establishing curriculum objectives and learning activities for students, the elements of knowledge that are identified by the teacher often include facts, generalizations, hypotheses, and the related concepts. All thinking and action involves concepts, the building blocks of knowledge (Martorella, 1991). David Palmer’s research supports the idea that application, or thoughtful action, is important to understanding.

“Research has shown that most students in grades 5-9 can correctly identify plants and animals as living things, but a good understanding of a concept such as ‘living and non-living’ does not simply involve a knowledge of which things are classified as which. An aspect that is equally important, but that is often neglected, is that students should also clearly understand how to apply this knowledge in relation to other biological concepts” (Palmer, 1998).
Concepts may be understood as categories into which we group phenomena within our experience. Phenomena are stored into concept categories as the individual comes to understand their basic or distinguishing characteristics (Martorella, 1991). There are three theories of conceptual development: The classical theory; the prototype or probabilistic theory; and the casual theory.

The classical view is organized around the idea that concepts are made up of categories that consist of summary lists of features, properties, or critical attributes, which are necessary for the concept to be included in that category. This theory has several problems. The first is that people have a hard time coming up with specific defining features for every concept. There are always exceptions to the 'rules' used to define a concept (Medin, 1989).

Another problem with this view is that it makes that claim that all examples of a concept are equally good because they possess the required defining features. Most people find some instances of a category more difficult to verify than others.

Finally, there is the problem of unclear cases. This view implies that we can unambiguously determine the categories for concepts. Yet, this is not the case with concepts like 'light', which can be included in both a wave and particle category. Two researchers, Stanley and Mathews, argued that the classical notion is inadequate to address the variety and complexity of
concepts in geography instruction. They determined that the defining
features of most concepts are complex and hard to specify; that category
boundaries often are not clear cut; and that individuals tend to view concepts
holistically, in terms of ‘best examples’ or ‘prototypes’, especially when the
concepts have fuzzy boundaries (Martorella, 1991).

The probabilistic or prototype view holds that categories are organized
around a set of properties of correlated attributes that are only characteristic
or typical of category membership (Medin, 1989). A prototype is a generalized
image of the concept, which may include only some of the concept’s defining
attributes, and so this makes the categories fuzzy or ill defined (Schunk,
2000). “Membership in probabilistic categories is naturally graded, rather
than all or none, and the better or more typical members have more
characteristic properties than the poorer ones” (Medin, 1989). One problem
with this theory is the idea that people would have to store thousands of
these prototypes in long-term memory. Another problem with this view is
that it treats concepts as being context-dependent. Driver and Easley (1978)
used the term “alternative frameworks” to describe children’s knowledge
structures that have developed through their experience of the physical
world rather than through geography or science education. “Many notions
children hold are used in a wide range of situations and have the
characteristics of elementary models or theories” (Driver, 1978). These
representations of "theory-like" knowledge structures were chiefly used to
describe one particular alternative conception that students had, and the
range of contexts to which it applied.

The casual theory is organized around the idea that concepts are used
in explanations, and are not just a sum of independent features. "The
features that are characteristically associated with the concept 'bird' are just a
pile of feathers unless they are held together in a "bird structure". Structure
requires both attributes and relations binding the attributes together. Typical
bird features have both internal and external structure based on interproperty
relationships. Building nests is linked to laying eggs, and building nests in
trees poses logistical problems whose solution involves other properties such
as having wings, flying, and singing" (Medin, 1989). In his study of emergent
systems, David Penner (2000) states that understanding many systems
requires going beyond merely determining the isolated behaviors of the
constituent components. "Rather, one needs to also consider the ways in
which the components interact. The properties attributable to the system as a
whole are not properties of the individual components that make up the
system. That is, in many systems, global system properties emerge as the
result of underlying interactions among system components" (Penner, 2000).

The casual theory is most useful to science and geography educators
for many reasons. For instance, the casual view includes the correlated
attributes plus the underlying principles between them. Rather than defining a category as simply a summation of attributes, the casual view categorizes by using a common explanatory principle. Instead of developing concepts from adding more features or attributes, the casual theory views conceptual development as the changing organization and explanations of concepts. It may be summarized that conceptualization depends not just on similarity or association, but also on the relationships between features and casual explanations (Keil, et.al. 1998).

Guidelines emerge for geography and science instruction from this extensive body of research on concept learning. Although there is a growing body of evidence to indicate that the structure of individual concepts is a significant variable to be addressed in selecting alternative modes of instruction, the guidelines below are submitted as a general instructional model for concept formation (Martorella,1991).

1. Identify the set of examples and place them in some logical order for presentation. Include at least one example that best illustrates an ideal type of the concept.

2. Include in the materials a set of questions, directions, and student activities that draw attention to the critical attributes and the similarities and differences in the examples used.

3. Direct students to compare other illustrations with the best example and provide feedback on the adequacy of their comparisons.

4. If critical attributes cannot be clearly be identified then focus attention on a few best examples of the concept.
5. Where a clear definition of a concept exists, state it at some point in the instruction in terms meaningful to the students.

6. Through discussion, place the concept in context with other related concepts that are part of the students' prior knowledge.

7. First assess concept mastery at a minimal level, namely, whether students can correctly discriminate between new examples.

8. Then assess concept mastery at a more advanced level; for example, ask students to generate new exemplars or apply the concept to new situations.

The Role of Fieldwork

Fieldwork Defined

Fieldwork is defined in many ways. It has a close connection to outdoor and environmental education. The student experiences fieldwork in a variety of ways. In some instances the teacher leads the fieldwork so that it is more like a lecture outside of class. In other instances the student fieldwork is conducted by filling in of worksheets based on direct observation. More true to the spirit of fieldwork is when the student actually gets his or her hands and feet dirty making measurements and collecting samples for later analysis in the classroom (Stoltman and Fraser, 2000).

Fieldwork is often defined as any structured experience that engages students in learning outside the classroom, and when the object of their studies-whether it is a prairie site, geological site or museum- is also the place where the students study. Foskett (1997) further elaborated that such outside classroom activity "provides pupils with experiences, knowledge,
understanding, or skills from part of the geography curriculum " (as cited by Kwan, 2000). Fieldwork perhaps may also be described as just the simple transference of words from the textbook into a real learning environment, such as a prairie would represent.

Fieldwork is most effective when it is seen as a method of planned discovery (Boud and Feletti, 1991). Prior to the fieldwork experience teachers need to prepare situations that allow students to work purposefully and meaningfully in a particular environment so that they find and confirm geographical facts and ideas in a holistic manner by using a number of geographical fieldwork techniques for themselves (Kwan, 2000).

The main difference between fieldtrips and fieldwork is the absence of scientific inquiry in the fieldtrip, and while fieldtrips sometimes require walking and collection of samples, they are more passive or have major components that are more passively organized than is fieldwork (Nairin, Higgitt, et al., 2000).

Others have addressed the clear distinction between fieldwork and fieldtrips. The Argentinean researcher, J. Ostuni, provides a snapshot of a fieldwork experience. "Students are organized in groups and they are provided with guides for the work to be performed on the field. The instructions in the guides are explained and clarified prior to departure. The place where the groups split is determined, the time is allotted for the
assignment, and the final meeting place is equally established” (Ostuni, 2000).

Alternatively, Ostuni classifies ‘information gathering’ as the main purpose of a fieldtrip (Table 1).

Table 1. Modalities of field teaching (Ostuni, 2000).

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Common or defining criterion</th>
<th>Description of activity by: Teacher</th>
<th>Description of activity by: Student</th>
</tr>
</thead>
<tbody>
<tr>
<td>Field Trip</td>
<td>Observation of terrain to obtain information</td>
<td>Informs or teaches aspects of itinerary</td>
<td>Takes notes passively</td>
</tr>
<tr>
<td>Field work</td>
<td>Observation of terrain to obtain information</td>
<td>Organizes and directs work</td>
<td>Participates actively in recording and communicates results</td>
</tr>
<tr>
<td>Field Investigation</td>
<td>Observation of terrain to obtain information</td>
<td>Counsels upon request from students</td>
<td>Designs and performs all activities</td>
</tr>
</tbody>
</table>

The effectiveness of fieldwork as a strategy in which students learn equally or more than using a textbook, classroom experience, or fieldtrip, is not well documented in the research. Conventional wisdom does suggest that hands-on, minds-on study outside the normal classroom and in natural or human landscape does have compelling benefits. Of the benefits that can be readily observed and recorded are those related to inquiry as a process for teaching and learning. “Fieldwork allows and requires the participants to view the world around them as a system of interwoven parts, like the texture of a fabric with its interlaced strands” (Stoltman and Fraser, 2000).
Educational Benefits of Fieldwork

Why did fieldwork emerge as a major component within geographic teaching and research? The response is threefold. First, geography is an empirical science. The data of geographic research are observations from the real world and largely from the present time (Holt-Jensen, 1980). The best means to collect these data is to encounter them where they exist, in the field outside the classroom. Second, the process of field study and observation reveals the relationships between elements on the surface of the earth. While an explanation for these relationships is embedded within the observations, the larger patterns are observable and may be mapped and analyzed (Board, 1965). Third, fieldwork lies at the heart of the geographic question: Where are things located in a particular place and why are they located there (Stoltman and Fraser, 2000)?

Bland (1996) stresses the importance of doing geographical fieldwork by stating that "geography without fieldwork is like science without experiments; the ‘field’ is the geographer’s laboratory where young people experience at first hand landscapes, places, people and issues, and where they collect data, learn and practice geographical skills in a real environment" (as cited by Kwan, 2000).

Fieldwork awakens the appreciation for the aesthetic value of the landscape, the respect and the responsibility for the delicate balance of the
environment. Contact with reality enables the student to participate critically and with solidarity in the community to make decisions that contribute to the solution of problems affecting the local territory (Ostuni, 2000).

What are the educational benefits of doing fieldwork in the environment? The literature suggests that students respond to fieldwork with an increase in academic achievement and positive attitude towards the environment. Most traditional fieldwork experiences benefit students' learning through the use of instrumentation in applying tools of field research to apply scientific inquiry to an issue or problem, or an object of interest. A second benefit is the direct involvement of students in taking responsibility for their own learning. Fieldwork requires that students plan and carry out learning in an independent manner. While fieldwork may occur in groups, each person has responsibility for a particular component, thus being responsible for the collection, verification, analysis, and reporting of information (Stoltman and Fraser, 2000).

Working in the environment and analyzing the dynamics of the environment send a powerful message to students about environmental ethics. The ethical questions underlying the ultimate responsibility for the environment, its quality, and its uses can be a lasting effect of learning through fieldwork (Stoltman and Fraser, 2000).
Fieldwork experiences allow students to become actively involved in the study of a restored ecosystem, such as prairie restoration. In the tradition of experiential learning, fieldwork provides opportunities to learn through direct, concrete experiences and the opportunity to apply technology to investigating problems and issues.

This active involvement within the prairie landscape "literally gives us business there, making us vital inhabitants of the system, not outsiders, but active participants" (Jordan, 1988). This creates a human/nature relationship, or an "ecological interaction with the natural landscape that benefits both it and us" (Jordan, 1988). Studying the restoration process provides also provides students with "...tangible evidence that human activity can have a positive effect on the landscape" (Aber and Jordan, 1985).

**Fieldwork as an Instructional Tool**

The researcher selected field instruction as the focal instructional activity for this study because it emphasizes experiential learning through the process of inquiry and because it can serve as a model for a constructivist approach. Piagetian theory advocated that provisions for direct experiential, relational opportunities assist and enhance learning. Novak (1976) contended that direct experience with real objects and processes give form and meaning to primary concepts and facilitate differentiation and application to more complex ones (Lisowski and Disinger, 1991).
From an early age, humans puzzle over phenomena of nature they encounter and ask many questions about them. Whether asked verbally or in actions, these questions indicate curiosity— an intense desire to know or to find out. Curiosity is thus a fundamental human trait. But how does one find answers to these questions? Is it by inquiring into them directly, or is it by obtaining answers from those who already know them?

What we do to get an answer to a question, and how we know when an answer is "correct," are also indications of human curiosity. Since curiosity is at the center of inquiry, these questions too are an integral part of inquiry, which in turn must be a human habit of mind and learning.

The National Science Education Standards, developed by the National Research Council (1996), elaborate major components of learning and teaching science through inquiry. "Students at all grade levels and in every domain of science," it states, "should have the opportunity to use scientific inquiry and develop the ability to think and act in ways associated with inquiry, including asking questions, planning and conducting investigations, using appropriate tools and techniques to gather data, thinking critically and logically about relationships between evidence and explanations, constructing and analyzing alternative explanations, and communicating scientific arguments" (NRC, 1996). Although this definition refers to qualities of inquiry that are especially related to the learning and practice of science,
inquiry also relates to learning in other areas of study. The application of fieldwork is apparent since students engage in inquiry while completing investigations in the field.

For a long time fieldwork was associated with observation, or observation was considered to be its main component. While it is true that observation is important in all scientific investigation, it is not enough in itself. Fieldwork involves other activities as well. If it is acknowledged that by definition observation is the result of observing, and to observe is to look or examine attentively, to scrutinize carefully, then it is evident that not any act of looking is observation. To observe is more than the mere act of looking we exercise in our daily lives. The act of observing is an important operation in scientific work, and its correct practice is what insures progress in any type of investigation (Ostuni, 2000).

Two definitions show us the essential function of observation:

1. Observation, understood in a broad sense, encompasses all procedures used in the social sciences not only in order to examine the sources where facts and data under study are found, but also in order to obtain them and record them so that they can enable us to know reality (Sierra Bravo, 1985, as cited by Ostuni, 2000).

2. It is a process that requires voluntary attention and intelligence, guided by an objective that is terminal, organizing, and directed towards an object in order to obtain information (De Ketele, J., 1984, as cited by Ostuni, 2000).

It is convenient to keep in mind that observation is the result of two components: the observer and the object observed. Observation defines a
relational situation, since in order for it to occur, the presence of both terms is required, and it can only be understood in the analysis of both (Ostuni, 2000). Observation not only bases itself upon the senses but it also resorts, as much as possible, to special instruments which pinpoint and widen the scope of the senses (Ostuni, 2000).

The result of observation becomes materialized in the form of description. Only through description can the result of observation be made known objectively, stating the purpose by which it is undertaken and the conceptual framework that sustains it (Ostuni, 2000). All students have some skill of observation using their five senses when they arrive in geography class. Fieldwork takes them back in to the same or different environment and demonstrates the importance of experiencing an environment first hand, as well as the means to hone those senses. More importantly, fieldwork provides the student with the experience in developing a geographic perspective in viewing the landscape, both natural and human (Stoltman and Fraser, 2000).

The active process of fieldwork aids in the development and application of observation and analytical skills. Fieldwork relies upon a range of skills, many of which are not used in the classroom. Observation of patterns in nature, taking measurements of dynamic processes, and using
classification... to organize and analyze the observed data are essential in fieldwork (Stoltman and Fraser, 2000).

A powerful set of skills and their application are developed and honed during fieldwork. Beyond the skill of observation are those of synthesizing information, evaluating information and making reasoned decisions about the efficacy of information. There are also the instrumentation skills that once learned, become life long skills. These include... field sketching and field mapping... and cameras to obtain a photographic record.... These are skills developed largely through students' interactions with their environments in the world outside the classroom (Stoltman and Fraser, 2000).

Conclusion

Students of school age are being prepared to be functional and responsible citizens of the larger society in which they live. Part of being a responsible citizen is being able to address problems and issues of public concern and make responsible personal and social choices regarding those problems and issues. Later in life, those same students become policy and decision makers at local, regional, and national levels. Therefore, the types of learning experiences through fieldwork should complement the inquiry process and problem solving. Scientific inquiry is a powerful and important means to that end. Fieldwork readily fits within the larger educational
practice of inquiry in that it involves higher order thinking. Higher order thinking entails classifying information collected in the field to answer a larger, more persistent problem. Learning does not cease with the collection of facts in fieldwork, but goes on to provide explanations, even though they may be tentative (Stoltman and Fraser, 2000).

The importance of field-based inquiry is supported by the research about the development of conceptual knowledge (Hinman, 1998). An important component of the research question about how students learn concepts of geography and other sciences is offered by constructivist theory (Rita, 1998). In short, constructivist theory proposes that a student brings along to each new learning situation a whole host of *a priori* beliefs and some of those, in the eyes of the students, are applied to newly introduced information and affect how it is interpreted by the student. It is here that fieldwork and constructivist theory in learning are directly related. An inquiry-based learning process, such as fieldwork, formalizes some of the new conceptual knowledge the student encounters, and part of the new information may conflict with existing conceptual framework the student has developed for concepts based on prior experience (Stoltman and Fraser, 2000).

The idea that students construct their own knowledge using information and concepts is widely observed in the literature of science
education. Conventional wisdom suggests that fieldwork does exactly the same thing using direct experience and subsequent reflections as the source of the information. While the connection between constructivist theory of learning and fieldwork seems natural, there is no body of research literature that has emerged addressing the question. A major research study in 1999 examined the role of fieldwork as experiential learning (Lai, 1999), building on the theory that experience of participation in fieldwork that give students direct experience in “doing” rather than “watching” made the learning more influential and durable.

The study by Lai cited a greater level of environmental awareness and the transfer of a fieldwork perspective to other aspects of schooling, both attributable to fieldwork. The study was not specifically designed to test constructivist theory through fieldwork, but it does examine how student used experientially based information to mentally construct ideas about the environment. Currently, there is no compelling set of research evidence that firmly suggests fieldwork is beneficial to learning. The role of personal experience in building and assessing constructive understanding as been perennially demonstrated by direct involvement in the laboratory and fieldwork exercises, and those observations and anecdotal accounts are numerous (Foskett, 1999).
As a result, conventional wisdom, tradition, and the positive benefits of socialization and experiential learning for students engaged in fieldwork are incorporated adequately to build a rationale to justify fieldwork as part of a curriculum at all levels of schooling. The practitioner looks at the same issue of research in fieldwork and concludes that we do much in education that is not supported by specific research evidence, and that there is a strong tradition of fieldwork within geography, geographic education, or instruction. Therefore, it is judged to be beneficial and sound educational practice since students both learn and apply skill, have memorable experiences, with the "real world" content of geography, and apply the overarching process of scientific inquiry to fieldwork (Stoltman and Fraser, 2000).
CHAPTER III
FIELDWORK IN THE GEOGRAPHY CURRICULUM

The Research Design

The purpose of this study is to determine whether the use of fieldwork, in which students use either field sketching or photography, will result in greater student achievement on a teacher made test. This researcher hypothesizes that students' who use photography as a fieldwork method will show greater gains on a prairie ecology concept test than will students who use the traditional fieldwork method of sketching to make their observations.

The research design was the pre-test, treatment, post-test model that is common to educational and psychological research (Stanley, 1963). Two groups of local high school students participated in the study, one group using photography and a comparison group using the sketching method. This study is important because it can aid other practitioners in determining the potential for fieldwork sketching and photography as fieldwork methods.

Two local teachers volunteered to have their students participate in the study. Two classes of high school students, biology and history of the U.S., were used in the study. Twenty-six students participated in the fieldwork experience. Thirty-eight percent of the subjects were female, 62% were male. Twenty-five of the students were Caucasian. All of the students were between the ages of 15-17. Due to absences during either the pre or post-test,
only 22 students were used in the statistical analysis of the data. Based on the teacher's observations, this sample is representative of a normal group of high school students that annually attend this school. Two negative aspects of this sample are evident. The first is the small size of the sample. The second is that the selection of the sample was based on the convenience of the researcher. A larger, randomized sample may have been more representative of the population of high school students from Southwest Michigan. However, there were positive aspects to the sample as well. Two positive aspects of this sample were: the direct involvement of the students with field instruments that would have been in short supply with a larger group; and, the added benefit that the smaller size of the sample allowed for more detailed observations of the students during the fieldwork experience. Due to the nature of this study and sampling procedure, the results of this study can only be generalized to a group of students of similar composition. The data reported for the pre and post comparisons will follow non-parametric models.

Materials

The Curriculum

Experiences are the key factors that shape the students relationship to the content and, ultimately, to their understanding of it.” (Horton, 1998)
Three documents, the National Geography Standards, AAAS Benchmarks for Scientific Literacy, and the Michigan Curriculum Framework, were used to help guide the selection of activities and their placement within the curriculum.

Within geography, exercises directed at the interpretation of a local landscape may be used to address many of the essential elements of the National Geography Standards. For instance, students working with maps or photos as they identify the changing land use in Kalamazoo county are addressing the element “The World in Spatial Terms”. Students using guides to distinguish and measure the physical and human attributes at a site are addressing the element, “Places and Regions”. When students reflect on the physical and human processes that create those patterns and use these data to interpret human-environment relationships, they are using the element, “Environment and Society”. Finally, when students use data to show how geography may be used to interpret the past and plan for the future, they are on their way to becoming geographically literate (Geography Education Standards Project, 1994) (Table 2).

All of these themes and activities were incorporated into this study. Similarly, these and other activities were used to address many of the essential elements of the Michigan Content Standards for geography
(Table 3). It was determined that the topic of this research study could be placed in either the middle school or high school curriculum.

Project 2061's Benchmarks for Scientific Literacy were used to provide recommendations on what students should know and be able to do within the topic of this study. These benchmarks describe levels of understanding and ability that all students are expected to reach on the way to becoming science-literate. The benchmarks addressed with the prairie curriculum are listed in Table 4.
Table 2. The National Geography Standards Met by an Investigation Into Prairie Ecology Using Classroom Activities and Fieldwork

<table>
<thead>
<tr>
<th>Standard</th>
<th>Description</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Standard 3</strong> The World in Spatial Terms: How to analyze the spatial organization of people, places, and environments on Earth's surface.</td>
<td>Explain how people perceive and use space. Apply concepts and models of spatial organization to make decisions.</td>
<td></td>
</tr>
<tr>
<td><strong>Standard 4</strong> Places and Regions: The physical and human characteristics of places.</td>
<td>Describe and interpret physical processes that shape places. Evaluate how humans interact with physical environments to form places.</td>
<td></td>
</tr>
<tr>
<td><strong>Standard 7</strong> Physical Systems: The physical processes that shape the patterns on Earth's surface.</td>
<td>Describe how physical processes affect different regions of the United States and the world.</td>
<td></td>
</tr>
<tr>
<td><strong>Standard 8</strong> Physical Systems: The characteristics and spatial distribution of ecosystems on Earth's surface</td>
<td>Analyze the distribution of ecosystems by interpreting relationships between soil, climate, and plant and animal life. Apply the concept of ecosystems to understand and solve problems regarding environmental issues.</td>
<td></td>
</tr>
<tr>
<td><strong>Standard 9</strong> Human Systems: The characteristics, distribution, and migration of human populations on Earth's surface.</td>
<td>Evaluate the impact of human migration on physical and human systems.</td>
<td></td>
</tr>
<tr>
<td><strong>Standard 14</strong> Environment and Society: How human actions modify the physical environment.</td>
<td>Evaluate the ways in which technology has expanded the human capability to modify the physical environment. Develop possible solutions to scenarios of environmental change induced by human modification of the physical environment.</td>
<td></td>
</tr>
</tbody>
</table>
Table 3. The Michigan Content Standards Met by an Investigation of Prairie Ecology Using Classroom Activities and Fieldwork

<table>
<thead>
<tr>
<th>Content Standard</th>
<th>Geographic Perspective</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Middle School</strong></td>
<td></td>
</tr>
<tr>
<td>2.1</td>
<td>Locate, describe, and compare ecosystems, resources, and human-environment interactions of major world regions.</td>
</tr>
<tr>
<td>2.2</td>
<td>Locate major ecosystems, describe their characteristics, and explain the processes that created them.</td>
</tr>
<tr>
<td>2.3</td>
<td>Explain the importance of different kinds of ecosystems to people.</td>
</tr>
<tr>
<td>2.4</td>
<td>Explain how humans modify the environment and describe some of the consequences of those modifications.</td>
</tr>
<tr>
<td><strong>High School</strong></td>
<td></td>
</tr>
<tr>
<td>2.1</td>
<td>Describe the environmental consequences of major world processes and events.</td>
</tr>
<tr>
<td>2.2</td>
<td>Assess the relationship between property ownership and the management of natural resources.</td>
</tr>
<tr>
<td><strong>Middle School</strong></td>
<td></td>
</tr>
<tr>
<td>4.3</td>
<td>Describe major patterns of world populations, physical features, ecosystems, cultures, and explain some of the factors causing the patterns.</td>
</tr>
<tr>
<td>Curricular Activity</td>
<td>Benchmark</td>
</tr>
<tr>
<td>-----------------------------</td>
<td>---------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Classroom and Fieldwork</td>
<td>The Scientific Enterprise, 1c: Many problems are studied by using information and skills from many disciplines.</td>
</tr>
<tr>
<td>Classroom and Fieldwork</td>
<td>The Earth, 4b: Life is adapted to conditions on earth.</td>
</tr>
<tr>
<td>Fieldwork</td>
<td>Diversity of Life, 5a: A great diversity of species increases the chance that at least some living things will survive in the face of large changes in the environment.</td>
</tr>
<tr>
<td>Classroom and Fieldwork</td>
<td>Interdependence of Life, 5d: Human activities can, deliberately or inadvertently, alter the equilibrium in ecosystems.</td>
</tr>
<tr>
<td>Classroom and Fieldwork</td>
<td>Flow of Matter and Energy, 5e: Human activities can change the flow and reduce the fertility of the land.</td>
</tr>
<tr>
<td>Classroom</td>
<td>Social Trade-Off's, 7d: Benefits and costs of proposed choices include consequences that are long-term as well as short-term.</td>
</tr>
<tr>
<td>Classroom and Fieldwork</td>
<td>Systems, 11a: In defining a system it is important to specify its boundaries and subsystems, and indicate its relation to other systems.</td>
</tr>
<tr>
<td>Fieldwork</td>
<td>Values and Attitudes, 12a: Know why curiosity is highly regarded in science and how it is incorporated into how science is carried out.</td>
</tr>
<tr>
<td>Fieldwork</td>
<td>Manipulations and Observation, 12c: Learning how to use new instruments.</td>
</tr>
<tr>
<td>Fieldwork</td>
<td>Communication Skills, 12d: Make and interpret scale drawings.</td>
</tr>
</tbody>
</table>
Instrument Development

Two instruments were used in this study. A questionnaire was used to determine the students' attitudes toward fieldwork and pre and post achievement tests were used to assess the students' knowledge of prairie ecological concepts (Appendix G). The questionnaire was adapted from an instrument used in a previous study on students' attitudes towards scientific fieldtrips (Orion and Hofstein, 1991). Orion and Hofstein calculated a reliability coefficient, Cronbach's alpha, for the fieldtrip questionnaire. The correlation coefficient for the questionnaire was 0.86 and the validity was considered satisfactory.

The second instrument for this study, bearing the title “Prairie Test”, was developed by the researcher (Appendix H). Instrumentation consisted of a written short-answer test that was designed similarly to assessment tasks on state level assessments. The instrument questions are summarized in Table 5.

Instrument validity, expressly content validity, was addressed by the review of the test by a faculty member, graduate students, and the cooperating teachers. The first draft of the Prairie Test was reviewed by a faculty member and graduate students' (3) of the Geography Department at Western Michigan University. The second draft was reviewed by the cooperating high school teachers' (2).
Table 5. Pre and Post-test Questions and Evaluation.

<table>
<thead>
<tr>
<th>Question #</th>
<th>Main Concepts</th>
<th>Scoring Guide</th>
</tr>
</thead>
<tbody>
<tr>
<td>1, 2, and 4</td>
<td>Location of the prairie biome locally and around the world</td>
<td>Question 1: 3 points</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Question 2: 4 points</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Question 4: 1 point</td>
</tr>
<tr>
<td>3, 5, 6, 7, and 10</td>
<td>Characteristics of a prairie biome (the types of plants and animals found there)</td>
<td>Question 5: 3 points</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Question 6: 3 points</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Question 7: 1 point</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Question 10: not scored</td>
</tr>
<tr>
<td>8, and 9</td>
<td>Biological diversity</td>
<td>Question 8: not scored</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Question 9: 2 points</td>
</tr>
<tr>
<td>11, and 12</td>
<td>Land use and habitat loss</td>
<td>Question 11: not scored</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Question 12: not scored</td>
</tr>
<tr>
<td>13</td>
<td>Importance of the prairie biome</td>
<td>Question 13: 2 points</td>
</tr>
</tbody>
</table>

The instrument reliability was calculated using the statistic software program SPSS (SPSS, 2001). A split half procedure was used. A reliability coefficient was calculated using the Spearman-Brown prophecy formula and was observed to be .79. Many classroom tests report reliability coefficients of .70 and higher. For research purposes, a rule of thumb is that reliability should be at least .70 and preferably higher (Fraenkel, 2000). The test was short, 15 items, and two of the items were short answer. The reliability of the
short answer items were controlled in part by the use of scoring guides that
provided inter-rater control (Appendix F).

Methodology

The Classroom and Fieldwork Experience

Day One

The researcher met with the students of each class, a sophomore
History class, and a sophomore Biology class, in order to introduce the study.
The presentation began with a brief description of the study, the student’s
role in the study was explained, as well as the location and date of the
fieldwork experience. The procedure for volunteering was then outlined
along with the importance of the consent letters. The teachers had previously
discussed the fieldwork experience location and date with each class and
handed out the consent forms. Completed consent forms were collected from
each class prior to the experimental treatment (Appendix B).

Students were given 25 minutes to complete a pre-test. The first part
of the experimental treatment, a map prompt and task, were introduced
immediately following the pre-test. The map activity was used to orient the
students to the historical and current extent of prairie in Southwestern
Michigan.
Day Two

The spatial tradition in geography was explained and the importance of mapping as a way to express spatial variability of phenomena was presented. The students were given a map of the extent of prairie in the U.S. and a map of the extent of grain crops in the U.S (Appendix C). The map of the crops was used as an overlay on top of the prairie map in order for the students to observe spatial patterns and relationships with both elements. The objective of this activity was to give the students a good idea of how agriculture, and people's behavior, has altered and eradicated much of the prairie vegetation. This activity extends beyond the question of where the prairie/agriculture is located to why it is located there. A second activity was used to orient the students to the existence of the prairie biome around the globe (Appendix D). This activity addressed the organization and distribution of phenomena across the earth's surface. The activity also enhanced the skill of analyzing patterns.

Day Three

The fieldwork experience was conducted at the Kalamazoo Nature Center in Kalamazoo, Michigan. The fieldwork was not a field trip as described earlier, and differentiated by Ostuni (2000). The students in the research were engaged in fieldwork in which they used instruments, made measurements, observed and recorded information, and completed a
fieldwork journal. These criteria qualify the treatment as fieldwork (Stoltman and Fraser, 2000). A prairie plot consisting of 5 acres of heritage prairie vegetation and 3 acres restored prairie were used for the fieldwork. Stations were set up using numbered wooden stakes along the prairie path. The students were randomly assigned to either the field sketching or the photography treatment groups. The students were given a journal, developed by the researcher, which described the fieldwork task required at each station (Appendix E). The first several pages of the journal define the prairie biome. A primitive map of the prairie plot was provided. The students were asked to draw a compass on the map before going into the prairie. The students were asked to mark each location of a station on the map.

At each station, students were asked to follow the instructions and complete the fieldwork task as directed by the journal. The journal acted as a sampling plan, with the students either taking sample data from the environment by photography or sketching.

Station One

The field task at station one was to introduce the students to the concept of plant biodiversity. The station was set up as a hula-hoop that surrounded a section of the lawn outside the prairie (Figure 2).
Figure 2. Fieldwork Journal Station One.

Figure 3. Fieldwork Journal Station Two.
Station Two
The field task at station two was to introduce the students to the prairie plant “Prairie Smoke” (Figure 3).

Station Three
The field task at station three was to introduce the students to the presence of insects on the prairie. Students were asked to count the number of visible insects at this station and to identify some pictures of insects that are found on a prairie. The students were then asked to find and draw, or photograph, a ‘spittle bug’.

Figure 4. Fieldwork Journal Station Four.
Station Four

The field task at station four was to observe the non-grass plants of the prairie. The first plant observed here was a common prairie plant, the mustard plant. The students were asked to measure its height, describe its color, and smell the flower (Figure 4).

Figure 5. Fieldwork Journal Station Five.
Station Five

The field task at station five was to acquaint the student to the changing plant diversity depending on the season. The students were asked to measure the height of a dead Queen Anne’s Lace, and to explain how it would be a benefit to have lots of little flowers that cover a large area of this plant (Figure 5).

Station Six

The field task at station six was used to orient the student to the diversity of grass species within the prairie. The students were asked to determine the species of grass at this station (switch grass) and to measure its height (Figure 6).

Figure 6. Fieldwork Journal Station Six.
Station Seven

The field task at station seven was to orient the student to the existence of prairie wildlife, in this case the prairie birds. The role of birds in the prairie ecosystem was described. The students were asked to observe the nesting boxes located off the prairie path and describe the bird species that inhabited them. The students were also required to use their sense of hearing to count the different number of birds they could hear (Figure 7).

Figure 7. Fieldwork Journal Station Seven.

Station Eight

The field task at station eight was to have the students practice fieldwork techniques, such as measuring wind speed, and air temperature (Figure 8).
Station Nine

Students within the sketch group were asked to sketch the dominant plant species found within the hula-hoop section of the prairie at station nine. Students within the photography group were asked to take a photograph of the most dominant species within the same area (Figure 9).

Figure 8. Fieldwork Journal Station Eight.
Station Ten

The observations of prairie soil and available sunlight were the fieldwork tasks at station ten. Students were asked to determine soil moisture and soil temperature (Figure 10). A sample of the soil was analyzed for its characteristics. Sunlight was measured using a light meter (Figure 11). Measurements were taken at the top of the tallest plant, and at the bottom of the tallest plant.

Figure 9. Fieldwork Journal Station Nine.

Station Eleven

At station eleven, the students’ task was to make observations of the whole prairie site and to describe the prairie biome (Figure 12). In order to engage the students in critical thinking, the students were asked to answer
the question “How do you think these plants and animals interact with each other in this ecosystem?” The students within the sketch group were asked to draw a broad view of the prairie while the students within the photography group were asked to take a photograph of the prairie.

Figure 10. Fieldwork Journal Station Ten Soil Moisture.

**Station Twelve**

The ‘shooting star’ was the focus of the fieldwork task at station twelve. Cages were placed around the plant to protect it from grazing deer. A sketch or photograph was requested from the corresponding group (Figure 13).
Station Thirteen

Station thirteen fieldwork engaged the students in the study of a flower. Both groups of students were asked to describe the lupine flower. The students within the sketch group were asked to draw the prairie plant from the top and side views (Figure 14). The students within the photography group were asked to take a picture of the flower.

Figure 11. Fieldwork Journal Station Ten Light Meter.
Figure 12. Fieldwork Journal Station Eleven.

Figure 13. Fieldwork Journal Station Twelve.
Station Fourteen

The fieldwork task at station fourteen was to have the students observe the differing characteristics of grasses and forbs. The students answered a series of questions about the cream-colored false indigo plant and the prairie grass surrounding it.

Station Fifteen

The students answered specific questions centered on a prairie plant called 'pucoon' at station fifteen, and constructed a description of this flower. Students within the sketch group were asked to draw the pucoon, while students within the photography group were asked to take a photograph of this flower.
Figure 14. Fieldwork Journal Station Thirteen.

Station Sixteen

Prairie mammals were the focus of station sixteen. A series of mammal and reptile artifacts were placed at this station so that the students could observe the diversity of animal life on the prairie. The students within the sketch group were asked to choose and draw one of the animal artifacts
found at this station. The students within the photography group were asked to place the bison fur on the grass and take a photograph of this artifact (Figure 15).

Figure 15. Fieldwork Journal Station Sixteen.

**Day Four**

The researcher met with the students during their next regularly scheduled class. (The fieldwork occurred on a Friday, so the next regular class met the following Monday.) After getting settled, the students were given their field journals and corresponding photographs. The researcher went over the field journal briefly with both groups of students.

Immediately after the follow-up activity, all students completed a posttest designed to measure knowledge of concepts and subject matter
presented before, during, and after the fieldwork experience. The same instrument, the Prairie Test, was used as the posttest for each group.

The photography students were asked to make a photo essay using their photographs from the fieldwork experience. The photo essay consisted of a series of photos, placed in order of each station, glued onto a poster board. Some students chose to label the photographs. The purpose of the photo essay was to give the student the opportunity to discover patterns by grouping photographs onto the poster board. The resulting photo essay can be viewed as a collection of data that can support the development of prairie ecological concepts. The students engaged in the field sketching did not complete a similar poster.

Scoring

The evaluation instrument was designed to measure knowledge change about prairie ecosystems that resulted from using either the fieldwork methods of photography or sketching during the fieldwork. It was hypothesized that students in the photography group would have higher mean scores than students from the sketch group on this evaluation. It was expected by the researcher that the use of cameras would have a motivational effect that would encourage greater detail of interaction with the content than would field sketching.
The researcher also administered a post treatment survey of attitude toward fieldwork at the conclusion of the research experiment (Orion and Hofstein, 1991). The intent was to use the survey data within the analysis of the pre and post test scores. However, these analyses did not lend themselves to the inclusion of the survey data. These data are discussed because they are interesting, not because they have any significant interaction with the test scores.

Correcting and scoring of the evaluations was completed immediately after the instrument was administered. Evaluations were scored using a scoring guide (Appendix F). The scoring guide was used to improve consistency in scoring. The discrete elements of each skill or task was determined for each question so that the researcher could determine the presence or absence of that element when determining the score for each question on the evaluation. This assessment approach is commonly used in science and geography classrooms and is considered to be objective, with only occasional subjective judgments required (Moran and Boulter, 1992). Four questions were struck from the evaluation due to lack of time in the study for the teaching of these concepts.
CHAPTER IV
DATA ANALYSIS

Results

Test scores and the result of each question were entered into a Microsoft Excel spreadsheet program for storage of data (Appendix J). Scores were entered into the spreadsheet by a code name, S1 or P1, to allow for tracking of individual students throughout the study. Students not present for both evaluations or who did not participate in the fieldwork experience were omitted from the study. This resulted in the loss of four subjects.

The analysis of the data was conducted using Microsoft Excel (Microsoft Excel, 2001) and included descriptive and inferential statistics. A t-test was used to examine whether the mean scores of achievement on the researcher designed Prairie Test for the two groups, sketching and photography, were significantly different from each other. Analyses were made relative to the principal research question: Did significant differences exist in achievement between the treatment group that used photography and the comparison group that used sketching as fieldwork methods. The descriptive statistical comparison is presented in Table 6.
Table 6. Descriptive Statistics for Comparison Treatments

<table>
<thead>
<tr>
<th></th>
<th>Sketching</th>
<th></th>
<th></th>
<th></th>
<th>Photography</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N = 11</td>
<td>Mean</td>
<td>SD</td>
<td>Range</td>
<td>N = 11</td>
<td>Mean</td>
<td>SD</td>
</tr>
<tr>
<td>Pre-test</td>
<td></td>
<td>12.09</td>
<td>3.70</td>
<td>12</td>
<td>12.27</td>
<td>1.95</td>
<td>6</td>
</tr>
<tr>
<td>Post-test</td>
<td></td>
<td>15.63</td>
<td>1.91</td>
<td>6</td>
<td>16.45</td>
<td>2.29</td>
<td>7</td>
</tr>
</tbody>
</table>

The photography group scored slightly higher on the pre-test than the sketch group (means of 12.27 and 12.09, respectively), with a difference of 0.18. The mean difference was determined by subtracting the sketch group mean score (Xs) from the photography group mean score (Xp). It was observed that the difference was not statistically significant (Table 7).

Correlation analysis, using a scattergram, indicate a pattern showing improvement from both groups as a result of the treatments. The scattergram for the sketch group pre and post-test scores (Figure 16) indicates a linear form; that is the points in the scattergram tend to form a straight line. The scattergram for the photography group pre and post-test scores (Figure 17) indicates a cluster of points with a slight linear trend. A line has been drawn through the middle of the data points in Figure 16 and Figure 17 to help show the relationship. Both scattergrams indicate a positive trend of improvement on the Prairie Test.
Figure 16. Scattergram of Pre and Post-test Scores for the Sketch Group.

Figure 17. Scattergram of Pre and Post-test Scores for the Photography Group.
A t-test was computed to determine whether the mean difference between the groups was statistically different. Using a 95% confidence interval, and 19 degrees of freedom, it was observed that the p-value was .89 (Table 7), thereby suggesting that the two groups are not statistically different on pretest scores.

Table 7. t-Test Comparison of Pretest Scores Using a 95% Confidence Interval.

<table>
<thead>
<tr>
<th></th>
<th>Sketch Group</th>
<th>Photography Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>12.09</td>
<td>12.27</td>
</tr>
<tr>
<td>Variance</td>
<td>13.69</td>
<td>3.82</td>
</tr>
<tr>
<td>Observations</td>
<td>11.00</td>
<td>11.00</td>
</tr>
<tr>
<td>Hypothesized Mean Difference</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Degrees of Freedom</td>
<td>19</td>
<td></td>
</tr>
<tr>
<td>Sum of the Squares</td>
<td>136.91</td>
<td>38.18</td>
</tr>
<tr>
<td>Estimated Standard Error</td>
<td>1.12</td>
<td>0.59</td>
</tr>
<tr>
<td>Pooled Variance</td>
<td>8.75</td>
<td></td>
</tr>
<tr>
<td>Standard Error Using Pooled Variance</td>
<td>1.26</td>
<td></td>
</tr>
<tr>
<td>t Statistic</td>
<td>-0.14</td>
<td></td>
</tr>
<tr>
<td>P-value for a One-tail Test</td>
<td>0.44</td>
<td></td>
</tr>
<tr>
<td>t Critical Value for a One-tail Test</td>
<td>1.75</td>
<td></td>
</tr>
<tr>
<td>P-value for a Two-tail Test</td>
<td>0.89</td>
<td></td>
</tr>
<tr>
<td>t Critical Value for a Two-tail Test</td>
<td>2.13</td>
<td></td>
</tr>
</tbody>
</table>

The study's internal validity was validated by the absence of a statistically significant (p>.05) difference between the two groups on mean scores on the pretest (Table 7).

Post-test differences are within a range of probability, attributed to the fieldwork methods being compared using the treatments presented by the
research. The $t$-test statistic suggests that while there was a difference in mean scores, it was not a statistically significant difference between the two groups of students for the pretest ($p > .05$).

The $t$-test statistics further suggest that while there were differences in the mean scores (Table 8), it was not a statistically significant difference as a result of fieldwork experience; $t(19) = -0.91$, $p > .05$, two-tailed.

Table 8. $t$-test Comparison of Post-test Scores Using a 95% Confidence Interval.

<table>
<thead>
<tr>
<th>Sketch Group</th>
<th>Photography Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>15.64</td>
</tr>
<tr>
<td>Variance</td>
<td>3.65</td>
</tr>
<tr>
<td>Observations</td>
<td>11.00</td>
</tr>
<tr>
<td>Hypothesized Mean Difference</td>
<td>0</td>
</tr>
<tr>
<td>Degrees of Freedom</td>
<td>19</td>
</tr>
<tr>
<td>Sum of the Squares</td>
<td>36.55</td>
</tr>
<tr>
<td>Estimated Standard Error</td>
<td>0.58</td>
</tr>
<tr>
<td>Pooled Variance</td>
<td>4.47</td>
</tr>
<tr>
<td>Standard Error Using Pooled Variance</td>
<td>0.90</td>
</tr>
<tr>
<td>$t$ Statistic</td>
<td>-0.91</td>
</tr>
<tr>
<td>P-value for a One-tail Test</td>
<td>0.19</td>
</tr>
<tr>
<td>$t$ Critical Value for a One-tail Test</td>
<td>1.73</td>
</tr>
<tr>
<td>P-value for a Two-tail Test</td>
<td>0.38</td>
</tr>
<tr>
<td>$t$ Critical Value for a Two-tail Test</td>
<td>2.09</td>
</tr>
</tbody>
</table>

The photography group engaged in the same content at the same field study site, but used cameras for the data collection, achieved a slightly higher post-test mean score than did the sketching group. These results suggest that photography had an effect on the student interaction, interest, motivation, or
attentiveness to the task that resulted in a slightly higher mean score, but one that was not statistically significant.

The final analysis conducted in this study was to determine the students' attitudes toward educational activities entailing fieldtrips and fieldwork. In order to investigate the role of attitudes toward the fieldwork in this research, the researcher administered a modified Orion and Hofstein (1991) measure of students' attitudes. The measure categorizes student predispositions toward various dimensions of learning via direct experience. The survey instrument is included in Appendix G. The survey was modified somewhat from instrument used in Orion and Hofstein's research. The number of questions was decreased, with two questions re-worded in order to simplify the question. Four dimensions were classified: 1) Learning Aspect, questions 1, 4, 6, 7, 11, 12, 13, 16, 17, and 18; 2) Social Aspect, questions 2, 5, 15, and 20; 3) Adventure Aspect, questions 3, 9; and 4) Environmental Aspect, questions 8, 10, 14, and 19.

Hungerford et al. (1985) defined attitude as a "complex mental construct (perception) that emerges out of an integration of an individual's belief and value systems" (Boerschig and De Young, 1993). The teaching/learning process that students engage in through fieldwork incorporates those values and attitudes (Ostuni, 2000).
The special atmosphere created during fieldwork fosters – more than any other teaching/learning situation – the strengthening or the creation of certain attitudes. Spontaneous and enthusiastic participation is created by work in the open air, and excellent results are obtained, sometimes going far beyond expectations. Students value this kind of teaching method because they are aware of the benefits it contributes to their learning. So much so that when consulted through questionnaires about a certain study program or course, their most frequent answer or suggestion is “the need to incorporate more fieldwork, since in the field they perceive everything with more clarity”, adding that “learning and retention of contents improves considerably” (Ostuni, 2000).

The Orion and Hofstein questionnaire uses a Likert scale of 1 to 4. A lower score on the questionnaire showed more positive attitudes toward fieldwork. The attitude questionnaire and data reveals predispositions to fieldwork among the students that may have had an interaction with the cognitive knowledge and skills acquisitions that resulted from the two fieldwork data collections methods, field sketching and photography. A scattergram of each group (Figures 18 and 19), plotting attitude and post-test scores, suggests that the photography group may have slightly more positive attitudes towards fieldwork activities, as well as, slightly higher post-test scores.
Figure 18. Scattergram of Sketch Group Attitude and Post-test Scores. (Note: Lower attitude scores suggest a more positive attitude.)

Figure 19. Scattergram of Photography Group Attitude and Post-test Scores. (Note: Lower attitude scores suggest a more positive attitude.)
The photography group performed somewhat better on the pre and post-tests and the photography group has somewhat lower mean scores on the attitude questionnaire (Table 9), suggesting a somewhat better attitude towards the fieldwork and related methodologies. Neither group of students in the study had negative attitudes towards fieldwork and related methodologies. While not confirmed by the research, it is worth noting that attitudes affect the degree to which a person is predisposed to engage in a learning activity. The role that such dispositions had on the performance of students in the fieldwork and in applying field sketching and photography methodologies are open to further investigation. A full analysis of the questionnaire data is provided in Appendix I.

Table 9. *t*-Test Comparison of Sketch and Photography Groups Attitude Toward Fieldtrips According to the Four Dimensions.

<table>
<thead>
<tr>
<th>Dimension</th>
<th>Sketch Group</th>
<th>Photography Group</th>
<th>t</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M  SD</td>
<td>M  SD</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Learning Aspect</td>
<td>1.90 0.82</td>
<td>1.86 0.64</td>
<td>0.36</td>
<td>.72</td>
</tr>
<tr>
<td>Social Aspect</td>
<td>1.73 0.90</td>
<td>1.70 0.63</td>
<td>0.14</td>
<td>.88</td>
</tr>
<tr>
<td>Adventurous Aspect</td>
<td>2.14 1.01</td>
<td>2.10 0.70</td>
<td>0.17</td>
<td>.86</td>
</tr>
<tr>
<td>Environmental Aspect</td>
<td>2.11 0.78</td>
<td>1.91 0.56</td>
<td>1.39</td>
<td>.17</td>
</tr>
</tbody>
</table>
CHAPTER V
SUMMARY AND CONCLUSIONS

Summary

The research reported in this study examined the effects that two fieldwork methodologies, field sketching and photography, had on student learning during a fieldwork experience in geography and science education. There were eleven students in each of two groups engaged in the same fieldwork activities. The fieldwork activity was controlled by a fieldwork manual that set specific tasks for each group, and by field station sites that required the students to observe, collect, and analyze the same prairie ecology content. The researcher, several observers, and two classroom teachers monitored student progress in completing the field manual.

The research study was limited by many conditions that develop when using students who are already assigned to classrooms. For example, the students used in the study were not randomly selected from a much larger cohort of students for participation in the study. It was a sample of convenience. Second, teachers who were willing to cooperate with the researcher, and students who could obtain permission from parents and guardians, further limited the sample. Students miss class, in an experimental design, the absence from one of the research components, whether it is a pre-test or instruction on a fieldwork method, excludes the
student from the research sample. While the difficulties cited in conducting such field based research with students are monumental, the research does provide information about how students responded to a carefully designed fieldwork manual, the differential effects of field sketching and photography methods when all other conditions were controlled for and held constant, and the role that students attitudes may have played in the learning of prairie ecology knowledge and concepts. The strengths of the study are with the careful treatment controls applied in the conduct of the research, making certain that the comparison groups had exactly the same treatments, except that one group used field sketching and the other group used photography as data recording methodologies.

Students were administered the same pretest, divided randomly into respective fieldwork groups, completed the fieldwork, were administered the same post-test and an attitude questionnaire, and submitted their fieldwork manuals for the researcher's analysis. Classroom instruction in preparation for the fieldwork occurred before and following the fieldwork, and controlled by virtue of the researcher being the presenter at those sessions during which fieldwork procedures, background content, and policies for participation were reviewed.

In summary, the students who were engaged in the fieldwork using photography showed somewhat better gains in pre to post-test scores on the
researcher designed, content test. Those data suggest that photography provided the students either greater motivation, a halo-effect, or required greater attentiveness to the task at hand since it was being viewed through the viewfinder on a camera, or some combination of those factors. Compared to the group using field sketching with pencil and paper, the group using photography had slightly higher scores based on the differences between the mean scores on the post-test.

The researcher also administered an attitude questionnaire in which the data suggested that the group of students using photography in the fieldwork were somewhat better disposed to the activity than were the students in the field-sketching group. While it is not possible based on sample size and other limiting factors in the research context, there is reason to speculate that attitudes may have had a positive effect on engagement in the fieldwork and on subsequent student learning. Neither group of students had negative attitudes towards the fieldwork and related methodologies.

Conclusions

There is a strong tradition of fieldwork within science, geography, and both science and geographic education. The positive benefits of socialization and experiential learning for students engaged in fieldwork have been discussed. Students both learn and apply skill, have memorable experiences,
with the "real world" content of geography, and apply the overarching process of scientific inquiry to fieldwork.

Both photography and sketching can serve as valuable teaching tools for the instructor and as a learning tool for the student. However, photography is a unique learning tool and has been viewed as an untapped educational resource (Stranix, 1975, Stone, 1978, and Templin, 1981). Photography can preserve the form, color, and pattern of a prairie and prolong the study of this beautiful landscape. Advances in technology have led to the development of digital photography that may decrease additional expenses such as developing costs and may provide more versatility as a teaching and learning tool than would the traditional use of sketching.

Recommendations

Recommendations based on the conclusions and the researcher's observations during this study include:

1.) Geography and science classrooms should continue using the fieldwork methods that emphasize instrumentation skills. These include field sketching, field mapping, and cameras to obtain a photographic record of phenomena.

2.) Geography and science educators should continue to study fieldwork as a teaching-learning process taking place in a unique learning environment.
3.) Fieldwork experiences benefit from pre-visit and post-visit activities in the classroom.

4.) A review of studies dealing with cognitive learning in the environment indicates the existence of some, but infrequent, cognitive-focused “in-the-environment” education and a meager research base in this area. Thus, a good deal remains to be researched about cognitive learning “in-the-environment” particularly about how effective it may or can be.

The use of two fieldwork methods by the high school students in this study has shown to improve student achievement and generated positive student attitudes. Teachers who use science and geography fieldwork methods effectively may integrate those methods with their curriculum and the content standards with a level of assurance they are positive experiences. Pre-, during-, and post-visit instruction will place the fieldwork into a context and provides students with the content and skills to maximize the educational potential of the experience. Effective teachers may go a step further to encourage the development of scientific and geographic literacy in their students by furnishing opportunities that foster the ability to engage in lifelong learning and to examine vital scientific and environmental issues from a critical and informed perspective.
Appendix A

Protocol Clearance from the Human Subjects Institutional Review Board
Date: May 3, 2001

To: Joseph Stoltman, Principal Investigator
    Meridith Beilluss, Student Investigator for thesis

From: Michael S. Pritchard, Interim Chair

Re: HSIRB Project Number 01-04-01

This letter will serve as confirmation that your research project entitled “Learning in the Prairie: The Impact of a Prairie Education Curriculum and the Contribution of Fieldwork to Student Learning” has been approved under the exempt category of review by the Human Subjects Institutional Review Board. The conditions and duration of this approval are specified in the Policies of Western Michigan University. You may now begin to implement the research as described in the application.

Please note that you may only conduct this research exactly in the form it was approved. You must seek specific board approval for any changes in this project. You must also seek reapproval if the project extends beyond the termination date noted below. In addition if there are any unanticipated adverse reactions or unanticipated events associated with the conduct of this research, you should immediately suspend the project and contact the Chair of the HSIRB for consultation.

The Board wishes you success in the pursuit of your research goals.

Approval Termination: May 3, 2002
Appendix B

Consent Form
Your student has been invited to participate in a research project entitled “Learning in the Prairie”. The purpose of the study is to research the contributions of geography fieldwork toward the understanding of concepts of ecology and U.S. History. This project is being conducted to fulfill Meredith Beilfuss’s master’s thesis requirement.

Your permission is required for your student to participate in this project. A geography pre-test, the prairie teaching unit, a fieldwork experience, and geography post-test are the parts of the research study. A student may elect not to participate in the project, but may attend the fieldwork experience. Lessons and activities from the unit will be presented in the classroom for two class periods prior to fieldwork. The fieldwork will be conducted for approximately 3 hours at a Kalamazoo Nature Center prairie plot. The fieldwork exercises will include activities such as measuring and recording reflected light from the vegetation, taking photographs of the prairie environment, and mapping the area under observation. If a student does not participate, there will be no negative effect on his/her school program. Although there may be no immediate benefits to your student for participating, there may eventually be benefits to the school and subsequently to students’ geography programs.

All test data and information will remain confidential. That means that the students’ name will be omitted from all test forms and a code number will be attached. The principal investigator will keep a separate master list with the names of the student and the corresponding code numbers. The researchers will share the results of the research with school officials for curricula planning. Once the data are collected and analyzed, the master list will be destroyed. All other forms will be retained for at least three years in a locked file in the principal investigator’s office. No names will be used if the results are published or reported at a professional meeting.

No risks are anticipated when students are being tested. The school will provide travel to and from the Kalamazoo Nature Center. As in all research, there may be unforeseen risks to your student. If an accidental injury occurs, appropriate emergency measures will be taken; however, no compensation or treatment will be made available to yourself or your student except otherwise specified in this permission form.
You may also withdraw your student from this study at any time without any negative effect on services to your student. If you have any questions or concerns about this study, please feel free to contact either Meredith Beilfuss at 387-3428 or Terry Butcher at 323-2161, extension 3141. You may also contact the chair of the Human Subjects Institutional Review Board at 387-8293 with any concerns that you may have.

This permission document has been approved for by the Human Subjects Institutional Review Board as indicated by the stamped date and signature of the board chair in the upper right corner. Subjects should not sign this document if the corner does not have a stamped date and signature.

Your signature below indicates that you, as parent or guardian, can and do give your permission for:
- to be tested before and after receiving instruction using the “Learning in the Prairie” unit;
- your student to participate in the fieldwork experience at the Kalamazoo Nature Center, and
- for these scores, if found to be useful, to be reported to his/her teacher.

Parent Signature ___________________________ Date ____________

Permission obtained by: ___________________________ Date ____________

(Researcher)
Appendix C

Classroom Maps
(Reduced Size)
Corn, Wheat and Grain Production in the United States

Prairie Boundaries in the United States

Appendix D

Prairie Ecosystem Activity
Name ____________________________

Please complete the questions below using your handout.

1. What do we mean by the word ecosystem?

A biome is a large terrestrial ecosystem characterized by specific plant communities. A biome is usually named after the predominant vegetation in the region.

2. Name two biomes.

3. Find the grassland biome on the world map handout. Shade the areas labeled MGr, the grassland biome, with a colored pencil.

4. At what latitude are most grassland biomes found on the Earth?

   ______ degrees N
   ______ degrees S

5. What is a niche?

6. Each part of the ecosystem, whether it be the ______________, ______________, or a ______________, or animal provides things that other parts of the ecosystem needs.

Look at the page titled, “The Great Food Chase”

7. What is a food chain?

8. If an animal is at the top of the food chain, it has no ______________

9. Look at the prairie food chain. What is the producer?

   ______________. What is the consumer? ______________. What is the decomposer?

   ____________________.
Appendix E

Learning in the Prairie Fieldwork Journal
(Reduced Size)
“Learning in the Prairie”

Journal

Name ____________________
WHAT IS A PRAIRIE? What makes it different from other fields?

A prairie is a natural grass and flower garden with less than one mature tree per acre. It is a community of plants and animals.

natural - native, to distinguish from the common field plants which are mostly introduced from Europe and Asia

glass - over 50% of the vegetation in a prairie is true grasses

flower(s) - the non-grass plants are called forbs. The most common forbs in a prairie belong to these plant families; composite (sunflower), and legume (pea)

tree(s) - where trees did occur on the prairie, they were usually bur oaks

community of plants - like a shortened forest, a variety of plants exist on a prairie because they don't compete for the same resources at the same time

and animals - all prairie animals are adapted to a grassland existence. The mammals that we identify with the prairie survived by running (antelope and bison), burrowing (prairie dog), and grazing (antelope and bison)

WHERE AND WHEN DID NORTH AMERICAN PRAIRIES OCCUR?

Prairies occupied that part of our continent between the forest and the desert, between rain and drought. It was once continuous from Indiana to the Rockies, in lands where corn and cows have taken its place.

Thirty million years ago the western mountains began to rise and intercept the humid western winds. This process caused a rain shadow so that less and less rain fell in the prairie lands. Western prairies got less rain and the grasses there were mostly short, less than three feet except in wet bottomlands. Eastern prairies got more rain and the grasses and forbs there grew tall, up to nine feet in deep rich soil.
HOW HAVE HUMANLY AND PRAIRIES INTERACTED?

North American Indians hunted bison on the prairies. Before they had horses they drove the animals with fire - down a steep bank or into a circle where they trampled each other. After a fall fire, the early spring growth attracted the bison and established new hunting grounds for the Indians.

Around their camps, the Indians collected prairie plants for medicine, drinks and dyes, sometimes completely removing a species from the area. However when the camps were abandoned the prairie vegetation quickly became re-established.

Early explorers were impressed by the vastness of the prairie, considering them waste regions and a barrier to exploration. Throughout our country's early development the prairie was a place to be conquered only by crossing it - no one could live in such nothingness.

With the invention of the iron plow in the 1830's, the prairie was doomed as agriculture spread quickly over the land. Now the deep thick grass roots could be sheared and turned by the plow, laying bare the richest soil yet found in America. While plowing destroyed most of the prairies, some were ruined by over-grazing.

In the western grasslands, white settlers was wealth in the form of cattle and sheep. They killed off competing herds of pronghorn and bison. The bison were killed for food and profit, and policy to undermine the American Indians. The bison population went from 60 to 75 million in the 1770's to 20 left in Yellowstone in 1894.

The American prairie was the breadbasket that supported the overflowing population from Europe for a century, from 1830 to 1930. There were heavy settlements of Germans, Poles, and Scandinavians.
Station #1
Station #1
Record the station location on your map.

Plant bio-diversity is defined as the number of different plant species on a site. This first site is a lawn. The most direct way to inventory the number of different plant species on a site is to count them. However, usually one cannot count all species in an ecosystem. Scientists take a sample, or a small portion of the system, and use this sample to estimate the total plant bio-diversity. The hula-hoop, or quadrat, marks off a small sample of this site.

1. Count and record the number of different plant species within the hula-hoop.

_______

2. If you are in the photo group, take a photograph of the most dominant plant species and record the photo number here _______. Otherwise, sketch the most dominant plant species in the box below. Be sure to take a picture or make a drawing that shows some details about this plant species.
Station #2

long, feathery hairs of seed head look like a "puff of smoke"
Station #2
Record the station location on your map.
Prairie Smoke

This is a common spring wildflower of meadows and prairies.

1. How long are the leaves? (estimate in inches) __________
2. This species usually has three flowers on one stalk. How many flowers are on
the stalks of these plants? __________

3. If you are in the photo group, take a photograph of the prairie smoke and record the
photo number here _______. Otherwise, sketch the prairie smoke in the box below ( or
record it in your lab notebook). Be sure to take a picture or make a drawing that shows
some details about this plant species.
Station #3

The prairie is home for millions of insects
Station #3
Record the station location on your map.

Can you identify the insects below?

Look around you. How many different kinds of insects do you see? Don’t forget to look out, up, and down.

Number of insects at this station  _______________________

Prairie Insects

hairy and black, reddish orange markings

golden brown, sips flower nectar

marked by speaches of pink, black and white

black and gold, important in pollination

forelegs look like praying hands

brown fly, fierce predator

pear shaped, discharges honeydew

dull black, buries dung

has 11 black spots

tiny black ant, burrows tunnels

black fly with gray markings

small black beetle

green green, dark brown head

one inch long, reddish green
Station #3

Spittle bug

Look at the plant near the stake. You should see a bubble of liquid on the stalk of this plant. Wipe away the liquid and you will find a spittlebug. Scientists think that the spittlebug excretes the liquid as camouflage. This is a common spring insect in the prairie.

1. Use the magnifier to look more closely at this fascinating insect.
2. If you are in the photo group, take a photograph of the spittlebug and record the photo number here _______. Otherwise, sketch the spittlebug in the box below (or record it in your lab notebook). Be sure to take a picture or make a drawing that shows some details about this insect species.
Station #4

- Prairie forbs
  - Purple prairie clover
  - Brown-eyed Susan
  - Stiff goldenrod
  - Resinweed
Station #4
Record the station location on your map.
Mustard Plant

Look at the plant near the stake. You should see lots of pretty yellow flowers on this plant. This plant is actually considered a weed of the prairie. Remember a weed is simply a plant that is not wanted. This is a common spring plant in the prairie.

1. Follow the instructions and answer the questions on the following page. Then,
2. If you are in the photo group, take a photograph of the Mustard plant and record the photo number here. Otherwise, sketch the Mustard plant in the box below (or record it in your lab notebook). Be sure to take a picture or make a drawing that shows some details about this plant species.
Briefing:
Station 1 includes the non-grass plants of the prairie, known as forbs or wildflowers. It is your mission at Station 1 to carefully examine these forbs and the insects that live in close association with them.

Strategy:
A. Search the prairie for forbs! How many do you see? If the forbs you have found are in bloom, list the different colors you see on the flowers.

B. Select one forb for special study. Compare your forb to the western lily drawn below. Though your forb may differ in some ways from this lily, you can use it as a guide as you answer the following questions.

- How tall is the forb you have found?
- What colors can you see on the forb?
- Does your forb have a flower(s)? If so, how many?
- Describe the flower.
- Smell the flower and describe the scent.
- Gently rub your finger along the stem of your forb.
- Describe the surface of the stem.
- Does your forb have leaves?

C. If your wildflower has a flower, you should study it closely. Does your flower have petals? a pistil? a style? a stamen? a anther? Draw and label your plant here:

D. Insects live in close association with the forbs at Station 2. Insects feed on the pollen and nectar produced by forbs and forbs depend upon insects to carry pollen from the male part of flowers to the female part of other flowers, a process known as pollination. The result is that forbs depend upon insects for survival and vice versa. The drawing of the western lily shows how pollen moves about the male and female parts of a flower.
Station #5

- White to pink flowers curved sharply upwards
- Showy yellow flowers
- Deeply cut leaves covered with long, silky hairs
- White, pea-shaped flowers
Station #5
Record the station location on your map.
Queen Anne’s Lace

Look for the tall, dead plant by the stake. You’re looking at last summer’s plant. This is a common late summer wildflower of meadows and prairies.

1. This species usually has lots and lots of flowers on one stalk. Why would it be of benefit to have lots of little flowers covering a large area on this plant? (Hint: What insect pollinates it and why would this arrangement be of benefit?)

2. Measure and record the height of this prairie forb. _______________ inches.

3. If you are in the photo group, take a photograph of the Queen Anne’s Lace and record the photo number here _______. Otherwise, sketch the Queen Anne’s Lace in the box below (or record it in your lab notebook). Be sure to take a picture or make a drawing that shows some details about this plant species.
Station #6

- Claw-like structure where leaf blade attaches to stem
- Nest of hairs where leaf blade attaches to stem
- Flowers look as if they were nodding
- 2-3 feet tall, very straight growing
- Needle-like seed attached to long awn that looks like a needle
- Seed head looks like a "turkey's foot"
The Role of Grasses in the Prairie Ecosystem:

The massive network of grass roots anchors the soil to the earth, thereby preventing erosion. The roots, combined with the soil, form a tough mass called sod which works like a sponge to absorb rainwater. The nutrient elements in the dead roots of grasses are recycled and kept in the soil until they are used to provide energy for living plants.

above ground, grasses dominate the prairie vegetation by taking up most of the space. Below ground, fungi and bacteria break down the weak roots of grasses into nutrient elements. These nutrient elements make the prairie soil very fertile.
Station #6
Record the station location on your map.

Prairie Grasses

Look for the tall, dead clump of grass by the stake.

1. Several grass species are described on the following pages. Read each one. Which grass species do you think this is?

2. Measure and record the height of this prairie grass. ___________ inches.

3. If you are in the photo group, take a photograph of this grass species and record the photo number here ______. Otherwise, sketch the grass species in the box below (or record it in your lab notebook). Be sure to take a picture or make a drawing that shows some details about this grass species.
Big bluestem is often the most dominant grass species of the tallgrass prairie. It is often called "turkey foot" because the seed clusters branch into three parts like a turkey’s foot. It can grow up to 8 feet tall with roots as deep as twelve feet. Big bluestem, Indian grass, and switch grass together made up over 80% of the plant biomass of the tallgrass prairie.
Indian grass grows throughout the tallgrass prairie in companion with big bluestem. Usually 4-6 feet tall, Indian grass grows in mesic prairie (neither extremely wet or dry). Along with big bluestem and switch grass, Indian grass provided the majority of food for bison and elk on the tallgrass prairie.
The seeds of switch grass are loose and widely spaced. Growing in clumps 3-6 feet tall, switch grass prefers low, moist soils. Like big bluestem and Indian grass, the winter stems of switch grass are resistant to winter winds and snows, providing important shelter for wildlife.
Station #7

Prairie Birds

black head and neck, "chinstap" on side of head

black, 6 ft wing span
Prairie Birds

Birds add color, movement and beautiful sounds to the prairie.

The chunky brown meadowlark sports a brilliant yellow throat and vest crossed by a black V. When this bird flies, two broad patches of white can be seen on either side of the tail.

The song of the upland sandpiper is one of the most beautiful and mysterious sounds on the prairie. While circling slowly in the sky, the sandpiper sings a long rolling whistle who/seeeeee whoo/0000

The Role of Birds in the Prairie Ecosystem:

In addition to contributing to the beauty of the prairie, birds help the ecosystem function smoothly. Birds that pick apart the fruits of plants help scatter the seeds that will someday grow as new plants. Birds that eat only plant parts are known as herbivores.

Other birds on the prairie eat both plant parts and animals. These birds, known as omnivores, are important because not only do they help scatter seeds but they also help control the population of insects.

Birds of the prairie that are equipped with sharp talons and/or beaks are usually carnivores, which means they only eat other animals.
Station #7
Record the station location on your map.

Prairie Birds

Look for the tall bluebird nesting boxes. Walk quickly and quietly away from them.

1. These bluebird nesting boxes are occupied by another bird species. Can you take a guess which one it is? If not, describe the bird you see flying into and out of the box in the space below.

2. Listen carefully for at least 10 seconds. Count and record the number of different bird calls that you hear.

3. If you are in the photo group, take a photograph of the bluebird boxes and record the photo number here ______. Otherwise, sketch the boxes or bird species in the box below (or record it in your lab notebook). Be sure to take a picture or make a drawing that shows some details about this bird species.

"Bob-o'-link, bob-o'-link,
Spink, spank, spink***
Station #8

The prairie vole cuts out surface runways—by clipping the grass and other vegetation very close to the ground. The vole travels these runways to reach underground tunnels. By clipping the stems of plants the vole stimulates new and better plant growth.
Station #8
Record the station location on your map.

Plant bio-diversity is defined as the number of different plant species on a site. This site is in the prairie biome. The most direct way to inventory the number of different plant species on a site is to count them. However, usually one cannot count all species in an ecosystem. Scientists take a sample, or a small portion of the system, and use this sample to estimate the total plant bio-diversity. The hula-hoop, or quadrat, marks off a small sample of this site.

Prairie Exploration
Plants that live in a community affect sunlight, water, and wind. Do the following:

I. Measure Wind Speed

<table>
<thead>
<tr>
<th>Plant Location</th>
<th>PRAIRIE</th>
<th>FIELD</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. In the road</td>
<td>_______ M.P.H.</td>
<td>_______ M.P.H.</td>
</tr>
<tr>
<td>b. At the top of the tallest plant</td>
<td>_______ M.P.H.</td>
<td>_______ M.P.H.</td>
</tr>
<tr>
<td>c. At the bottom of the tallest plant</td>
<td>_______ M.P.H.</td>
<td>_______ M.P.H.</td>
</tr>
</tbody>
</table>

II. Air Temperature

<table>
<thead>
<tr>
<th>Plant Location</th>
<th>PRAIRIE</th>
<th>FIELD</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. In the road</td>
<td>_______ °F</td>
<td>_______ °F</td>
</tr>
<tr>
<td>b. At the top of the tallest plant</td>
<td>_______ °F</td>
<td>_______ °F</td>
</tr>
<tr>
<td>c. At the bottom of the tallest plant</td>
<td>_______ °F</td>
<td>_______ °F</td>
</tr>
</tbody>
</table>

What types of plants dominate the area?
COUNT THE NUMBER OF GRASSES IN THE STUDY AREA
COUNT THE NUMBER OF OTHER FLOWERING PLANTS
TOTAL NUMBER OF PLANTS

III. If you are in the photo group, take a photograph of the most dominant plant species and record the photo number here _______. Otherwise, sketch the most dominant plant species in the box below. Be sure to take a picture or make a drawing that shows some details about this plant species.
The nest of the grasshopper sparrow is built of stems and blades of grass and is hidden in clumps of vegetation on the prairie floor.
Station #9
Record the station location on your map.

Plant bio-diversity is defined as the number of different plant species on a site. This site is in the prairie biome. The most direct way to inventory the number of different plant species on a site is to count them. However, usually one cannot count all species in an ecosystem. Scientists take a sample, or a small portion of the system, and use this sample to estimate the total plant bio-diversity. The hula-hoop, or quadrat, marks off a small sample of this site.

What types of plants dominate the area?
COUNT THE NUMBER OF GRASSES IN THE STUDY AREA
COUNT THE NUMBER OF OTHER FLOWERING PLANTS
TOTAL NUMBER OF PLANTS

MEASURE THE HEIGHTS OF THE 5 TALLEST PLANTS IN THE STUDY AREA

PRAIRIE

FIELD

PLANT 1
PLANT 2
PLANT 3
PLANT 4
PLANT 5

PLANT 1
PLANT 2
PLANT 3
PLANT 4
PLANT 5

*ADD THE TOTAL HEIGHTS AND DIVIDE BY 5 TO GET THE AVERAGE HEIGHT

III. If you are in the photo group, take a photograph of the most dominant plant species and record the photo number here ________. Otherwise, sketch the most dominant plant species in the box below. Be sure to take a picture or make a drawing that shows some details about this plant species.
Station #10

**Badger**

With its strength and sharp teeth and claws, the badger defends itself against all predators, except man.

When night falls on the prairie, the badger surfaces from its burrow to stalk its prey. It smells a ground squirrel or mouse, it begins digging with its stout fore claws. Because of its tireless energy and amazing speed, it can catch most of its prey before they can escape their burrows.

By day this handsome, yellowish-red fox usually sleeps concealed in a clump of grasses.

During the nighttime hours, the fox travels the prairie floor to stalk its prey, usually rabbits and mice but also birds and insects. Once prey is spotted, the fox takes slow, deliberate steps or crouches and wiggles toward it. It then rushes its victim and kills it with a bite from its powerful jaws. In summertime, the fox also feeds on the berries of plants.

4-9 young foxes, called "kits" are born in March and raised in an underground den.

The fox defends itself against enemies with its quick speed and cunning. It is taken by only a few predators, including man.
The story of the prairie begins with its rich black soil.

The topsoil is made rich by humus or decaying plant and animal materials. The top layer of soil is called topsoil. Millions of dead and living roots form thick rough masses called sod. The soil contains many tunnels and burrows for animals.

The Role of Soil in the Prairie Ecosystem:

The tough prairie sod is a great conserver of water and soil. When it rains on the prairie, the sod acts like a giant sponge catching and holding the rain water. As a result, the amount of water runoff from the prairie is small compared to other lands where there is no strong network of roots to absorb the rain. Those same roots also bind the soil tightly to the earth, protecting it against erosion or the washing or blowing away of soil from the forces of water and wind. The roots in the soil are not only strong, they are numerous. A square yard of soil four inches deep may contain roots that would stretch for twenty miles if all were placed from end to end.

In or on the prairie soil, as many as 641,000 fungi and more than 20 million bacteria per acre are at work breaking down dead plant and animal materials into important nutrient elements such as carbon and nitrogen. Those nutrient elements are stored in the soil until they are taken in through the roots of plants. The end result is that dead materials are recycled into nutrient elements that can be used to help plants grow. This is what is meant by nutrient element cycling.

Animals, too, depend on the soil as a refuge. The prairie mouse builds its small nest underground and hoards seeds for winter use in burrows near its nest. The badger uses its burrow in spring as a nest chamber where it raises its young and sometimes in winter a place to sleep for several days. Although it does not hibernate, the Franklin’s ground squirrel hibernates in its burrow throughout the winter months. Many birds, reptiles and amphibians also find refuge and food at the soil level.

The prairie soil is not only a storehouse of nutrients for plants, it is also a shelter. When harsh weather or fire sweeps across the prairie, the roots and buds of plants are tucked away safely in the soil. And when the aboveground parts of plants wither and die in late summer and fall, the roots or buds live on through the winter, waiting to send new shoots up through the soil in spring.
Station #10
Record the station location on your map.

Soil Texture Analysis

1. Look for the soil moisture and light meter in the box next to the stake. Place the metal probe gently into the soil. Switch the meter so that it will indicate the moisture level. The reading ranges from 1-10.
   Record the soil moisture: ________________.
   Usually prairie biomes are dry. How many inches of rain per year will this biome receive? ________________.

2. Remember that soil plays an important role in this prairie biome. Analyze the characteristics of the soil by placing a small amount into the plastic cup.
   How does it feel? (Circle your answer or add your own description)
   a. loose
   b. gritty
   c. smooth, floury
   d. smooth, sticky
   What does it look like?
   a. mostly sand grains
   b. many sand grains, some finer grains
   c. flour-like
   d. putty-like

3. Measure and record the soil temperature by gently inserting the soil thermometer into the ground. ________________ degrees.

4. Sunlight
   a. In the road
   b. At the top of the tallest plant
   c. At the bottom of the tallest plant
Station #11

A Prairie looks like an ocean of grass.

Big bluestem grows to be 6' tall or more. Grass species vary in height.

Switchgrass can grow to be 3-6' tall in moist soil.

Different species of grasses grow in different types of soil according to moisture.

Side-oats grama grows to be 1-3' tall in dry soil. Its "oat-like" seeds line up on one side of its stem. Grass species vary in structure.
Station #11
Record the station location on your map.

1. Look out over the whole site and describe the prairie biome. Talk about the ‘living conditions’ you observe, the slope of the land, abundance or absence of trees, and other plants. How do you think these plants and animals interact with each other in this ecosystem?

2. If you are in the photo group, take a photograph of the prairie and record the photo number here ______. Otherwise, sketch a broad view of the prairie in the box below (or record it in your lab notebook).
Station #12
Station #12
Record the station location on your map.

Shooting Star

1. Look at the cages around these flowers. The deer like to eat this prairie forb. The cages protect the plants from the hungry deer.

2. Look more closely at the flowers, but be careful not to step on other small plants. The flowers are nodding with backward pointing petals that bloom in flat clusters. The leaves are close to the ground. What is the leaf shape? _________________

3. If you are in the photo group, take a photograph of the shooting star and record the photo number here ______. Otherwise, sketch a shooting star in the box below (or record it in your lab notebook).
Station #13

Deep blue tubular shaped flowers

Long, feathery hairs of seed head look like a "puff of smoke"
A Flower Study

1. Get a close up look at a flower. Study the flower from all angles with a hand lens. Observations:

2. Use pencil and colors to sketch your flower.

   Top View

   Side View

3. Use your notes to write a description of your flower so that anyone could pick out your flower from the bunch.
Station #14
PRAIRIE PLANTS

Find a grass. Is the leaf flat or round? ___________

Find the flower stem. Is it flat or round? ___________

Rub your fingers on the flower. Did your fingers turn yellow? If they did, your grass is in bloom. Look at its flowers with a magnifier.

Find a forb (prairie wildflower). Gently feel the leaf. Is it rough? fuzzy? Waxy? ______

Are the leaves whole or divided into little sections? ___________

Does the leaf point toward the sky? ______

Watch your forb for a few minutes. How many kinds of insects are on it? ______

Are any of the insects pollinators? ______

Do you think the flower attracts pollinators by its bright color or its fragrance?

On the back of this paper make a sketch of your grass and your forb.

Estimate the height of your grass ____ your forb _______
Station #15
Station #15
Record the station location on your map.

Pucoon

1. Look for this yellow flowering forb. This early prairie bloomer blooms before taller species around it reach their peak growth and crowd out its characteristic showy flowers. Look more closely at the flowers, but be careful not to step on other small plants.
2. What is the leaf shape? ____________________
3. How do the leaves feel? ________________________
4. Are the leaves hairy or coarse? __________________
5. Complete the flower study on the next page.

6. If you are in the photo group, take a photograph of the Pucoon and record the photo number here ______. Otherwise, sketch a Pucoon in the box below (or record it in your lab notebook).
Station #16

Prairie Mammals

black and white, unusual and powerful defense strategy

gray, 44 to 54" long, hunts by night

handsome, yellowish red, stalks prey by night

brown, guides itself by sonar system

gray with black specks, hunts by day

brownish gray, travels long surface runways

buff to rusty brown, feeds morning and late afternoon
Prairie Mammals

Prairie mammals vary greatly in size even though the largest ones have vanished from Illinois.

Bison and elk were once the largest mammals on the Illinois prairie. During settlement of Illinois, however, huge numbers of bison and elk were killed by people and the prairie was plowed up and used as farmland and cities. Without a safe habitat to live in, the mighty bison and graceful elk vanished from Illinois.

Medium-sized animals such as the coyote, fox and badger are the big mammals on the prairie that remains in Illinois.

The Role of Mammals in the Prairie Ecosystem:

Mammals are vital to the flow of food energy in the prairie ecosystem. Some mammals like the badger, coyote and red fox are most important as predators because they keep insect and rodent populations under control. Other mammals like the cottontail rabbit and prairie vole are most important as sources of food for other members of the ecosystem. Some mammals such as the little brown bat and Franklin’s ground squirrel are important as both predators and prey.

You learned in the word picture at the top of this page the meaning of the word “niche”. The niche of an animal is very important because it guarantees each species a place to live and food to eat. With each species having its own niche, there is less competition between species for space and food. If an animal loses its niche, it cannot survive.

The Franklin’s ground squirrel captures an American toad. Food energy is transferred from the toad to the ground squirrel.
Station #16
Record the station location on your map.

Mammals and other animals on the prairie

1. Look for bison (buffalo) fur in the plastic tub.
2. What is the bison fur color? ______________________
3. How does the fur feel? ____________________________
4. Look for the coyote fur. Does it feel differently?
5. Look at the rattlesnake skin. Does the color blend in with the grasses?
6. If you are in the photo group, place the fur on the grass and take a photograph of the bison fur. Record the photo number here ______. Otherwise, chose an animal and sketch the artifact in the box below (or record it in your lab notebook).
Appendix F

Scoring Guide
(Reduced Size)
### Scoring Guide for Pre and Post Prairie Test

**Pre or Post ____**

**Group**

**Total Score**

#### 1. Prairie States

<table>
<thead>
<tr>
<th>Objective</th>
<th>No Answer given</th>
<th>Low performance</th>
<th>Average performance</th>
<th>Exemplary Performance</th>
<th>Earned points</th>
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<tbody>
<tr>
<td>To correctly identify the locations of prairies in the United States by shading in each state that contains a prairie biome.</td>
<td>0 points: Does not complete the question.</td>
<td>1 point: Identifies less than 4 states correctly.</td>
<td>2 points: Identifies between 5-8 states correctly.</td>
<td>3 points: Identifies between 9-11 states correctly.</td>
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</table>

**Score:**

#### 2. Global Prairie Biome Locations

<table>
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<th>Objectives</th>
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<th>High Performance</th>
<th>Earned points</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Describe the global location of prairie biomes by identifying a place name or the latitude of where most can be found around the world.</td>
<td>0 points: Does not complete the question.</td>
<td>1 point: The student identifies one global location of a prairie biome.</td>
<td>2 points: The student identifies two global locations of a prairie biome or gives the general latitude where it can be found around the world.</td>
<td></td>
</tr>
<tr>
<td>2. The student describes two characteristics of a prairie biome.</td>
<td>0 points: Does not complete the question.</td>
<td>The student describes one characteristic of a prairie biome.</td>
<td>The student describes two characteristics of a prairie biome.</td>
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**Score:**

#### 3. Prairie Climate and Predominant Vegetation

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<th>High Performance</th>
<th>Earned points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Identify the prairie climate as dry and predominant vegetation as grasses rather than as trees.</td>
<td>0 points: Does not complete the question.</td>
<td>1 point: Identifies climate as wet, with the predominant vegetation as grasses.</td>
<td>2 points: Identifies climate as dry and predominant vegetation as grasses.</td>
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</table>

**Score:**
4. **Prairie in Michigan**

<table>
<thead>
<tr>
<th>Objective</th>
<th>No Answer given</th>
<th>Exemplary Performance</th>
<th>Earned points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Identify the historic presence of prairie in Southwest Michigan.</td>
<td>0 points: Does not complete the question.</td>
<td>1 point: The student correctly identifies the presence of prairie in Southwest Michigan. (True)</td>
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Score: 

---

5. **Listing of Plants and Animals on the Prairie**

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<th>Average</th>
<th>Exemplary Performance</th>
<th>Earned points</th>
</tr>
</thead>
<tbody>
<tr>
<td>The student will list the plants, animals and insects that live on a prairie biome.</td>
<td>0 points: Does not complete the question.</td>
<td>1 point: Lists fewer than 4 plants and animals.</td>
<td>2 points: Lists between 5-8 plants and animals.</td>
<td>3 points: Lists nine or more plants and animals, or lists 2 or more specific plants or animals that are found growing in a southwest Michigan prairie.</td>
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Score: 

---

6. **Draw a Food Chain/Web.**

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<th>Exemplary Performance</th>
<th>Earned points</th>
</tr>
</thead>
<tbody>
<tr>
<td>The student will draw a food chain or food web that could represent a prairie.</td>
<td>0 points: Does not complete the question.</td>
<td>1 point: The student uses 2 or fewer food chain links.</td>
<td>2 points: The student uses 3-4 food chain/web links.</td>
<td>3 points: The student uses 5 or more food chain/web links.</td>
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Score:
7. Indicator of Biological Diversity

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<th>Earned points</th>
</tr>
</thead>
<tbody>
<tr>
<td>The student identifies an indicator of prairie biological diversity as an area of nearly all grasses</td>
<td>0 points: Does not complete the question.</td>
<td>1 point: The student identifies the best indicator of prairie biological diversity as an area of nearly all grasses.</td>
<td></td>
</tr>
</tbody>
</table>

Score: 8

8. The Negative Effect of Agriculture on Biological Diversity

Not scored

9. Determining Biological Diversity

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<th>High Performance</th>
<th>Earned points</th>
</tr>
</thead>
<tbody>
<tr>
<td>The student will describe how to determine the biological diversity of a given area of prairie landscape.</td>
<td>0 points: Does not complete the question.</td>
<td>1 point: The student describes the differences between plants</td>
<td>2 points: The student describes the differences between plants as well as counting the different plant species.</td>
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</table>

Score: 10

10. Prairie Importance

<table>
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<tr>
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<th>High Performance</th>
<th>Earned points</th>
</tr>
</thead>
<tbody>
<tr>
<td>The student explains why the prairie is important</td>
<td>0 points: Does not complete the question.</td>
<td>1 point: The student gives one reason.</td>
<td>2 points: The student gives two, or more, reasons, or identifies the prairie as a unique environment.</td>
<td></td>
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</tbody>
</table>

Score: 12
Appendix G

Fieldtrip Attitude Questionnaire
(Reduced Size)
INSTRUCTIONS: Please rate how strongly you agree or disagree with each of the following statements by circling your response.

1 = strongly agree 2 = agree 3 = disagree 4 = strongly disagree

1. 1 2 3 4 The field trip helps in understanding of material learned in class.

2. 1 2 3 4 The field trip is a waste of time.

3. 1 2 3 4 What I like in a field trip is the adventure.

4. 1 2 3 4 I would like to participate in more field trips since this is a good way to learn the subject.

5. 1 2 3 4 I would like to have more field trips since they are a lot of fun.

6. 1 2 3 4 The things I observe in the field trip do NOT help me in understanding the material taught in class.

7. 1 2 3 4 Field trips are an enjoyable way to learn.

8. 1 2 3 4 I like to go on field trips, since it is important for me to understand the environment in which I live.

9. 1 2 3 4 I return from field trips with a lot of experiences.

10. 1 2 3 4 The field trip increases one's awareness of environmental issues.

11. 1 2 3 4 After a field trip, I do NOT remember the explanations given by the teacher.

12. 1 2 3 4 The field trip is important since it demonstrates and illustrates the concepts learned in class.

13. 1 2 3 4 The material learned during the field trip will remain in my memory for a long time.
INSTRUCTIONS: Please rate how strongly you agree or disagree with each of the following statements by circling your response.

1 = strongly agree  2 = agree  3 = disagree  4 = strongly disagree

14. 1 2 3 4 I would like to have more field trips, since it helps in educating for nature conservation.

15. 1 2 3 4 I would like to have more field trips, since they help in building class spirit.

16. 1 2 3 4 Learning in the classroom is more effective than learning during a field trip.

17. 1 2 3 4 The field trip increases my enjoyment of the subject matter.

18. 1 2 3 4 The field trip does NOT increase my interest in the material we are learning.

19. 1 2 3 4 I understand natural phenomenon better after observing them in a field trip.

20. 1 2 3 4 The comments and jokes made by my classmates during the field trip interfere with my ability to concentrate on learning.
Appendix H

The Prairie Test
(Reduced Size)
Prairie Test

Name ______________________________

Directions:
Read each question thoroughly and answer all questions. Write all answers in the space provided.

1. Shade the area on the U.S. map that shows the locations of prairie biomes.

2. Write a brief description of where prairies are located on the earth. Write two things you know about prairie biomes.
3. A prairie biome is characterized by:
   a. dry climate, grasses
   b. wet climate, trees
   c. wet climate, grasses
   d. dry climate, trees

4. Prairies once covered large areas of Southwest Michigan. True or False

5. List the plants, animals, and insects that live in or on a prairie biome:
   
   **PLANTS**   **ANIMALS**   **INSECTS**

6. Using the list from your answer to Question #5, draw a food chain or food web that could represent a prairie:
7. Which is the best indicator of biological diversity in a prairie biome?
   - all grasses
   - nearly all grasses
   - few grasses
   - missing grasses

8. What is one negative effect of agriculture on biological diversity?

9. Given the area of land below, how would you determine its biological diversity?

Write your explanation in this box.
10. Use the classification key and the picture to determine the name of this prairie plant

11. Which land use has been most responsible for the loss of prairie habitat in Michigan?
   a. mining
   b. agriculture
   c. urban development
   d. recreation

12. Fire may be used as a management tool to combat invasive weeds in favor of native prairie plants. True or False

13. Explain why the prairie biome is important.
Appendix I

Analysis of Orion and Hofstein (1991)
Questionnaire Data
Along the Four Dimensions
<table>
<thead>
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<th></th>
<th>Learning Dimension</th>
<th>Adventure Dimension</th>
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<tbody>
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Appendix J

Prairie Test Raw Scores:
Photography and Sketching Groups
### Sketching Group: Item Points Awarded on Pre-test

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<tr>
<th>Sketching Group Raw Scores</th>
<th>Item 1</th>
<th>Item 2</th>
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